3 MARCH 1961

METAL INDUSTRY

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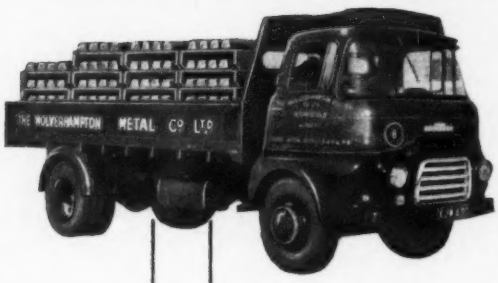
Forth Bridge, Scotland



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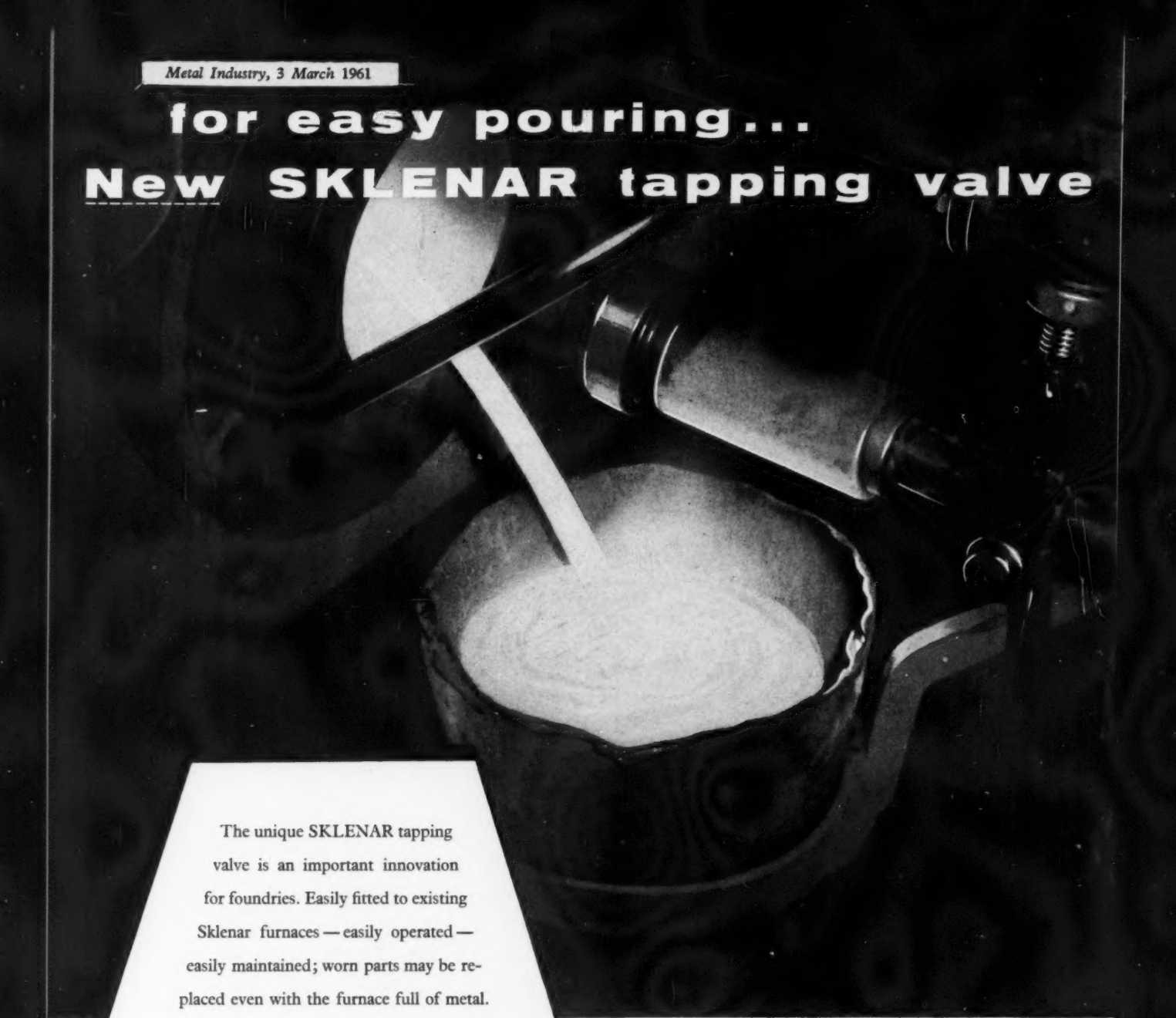

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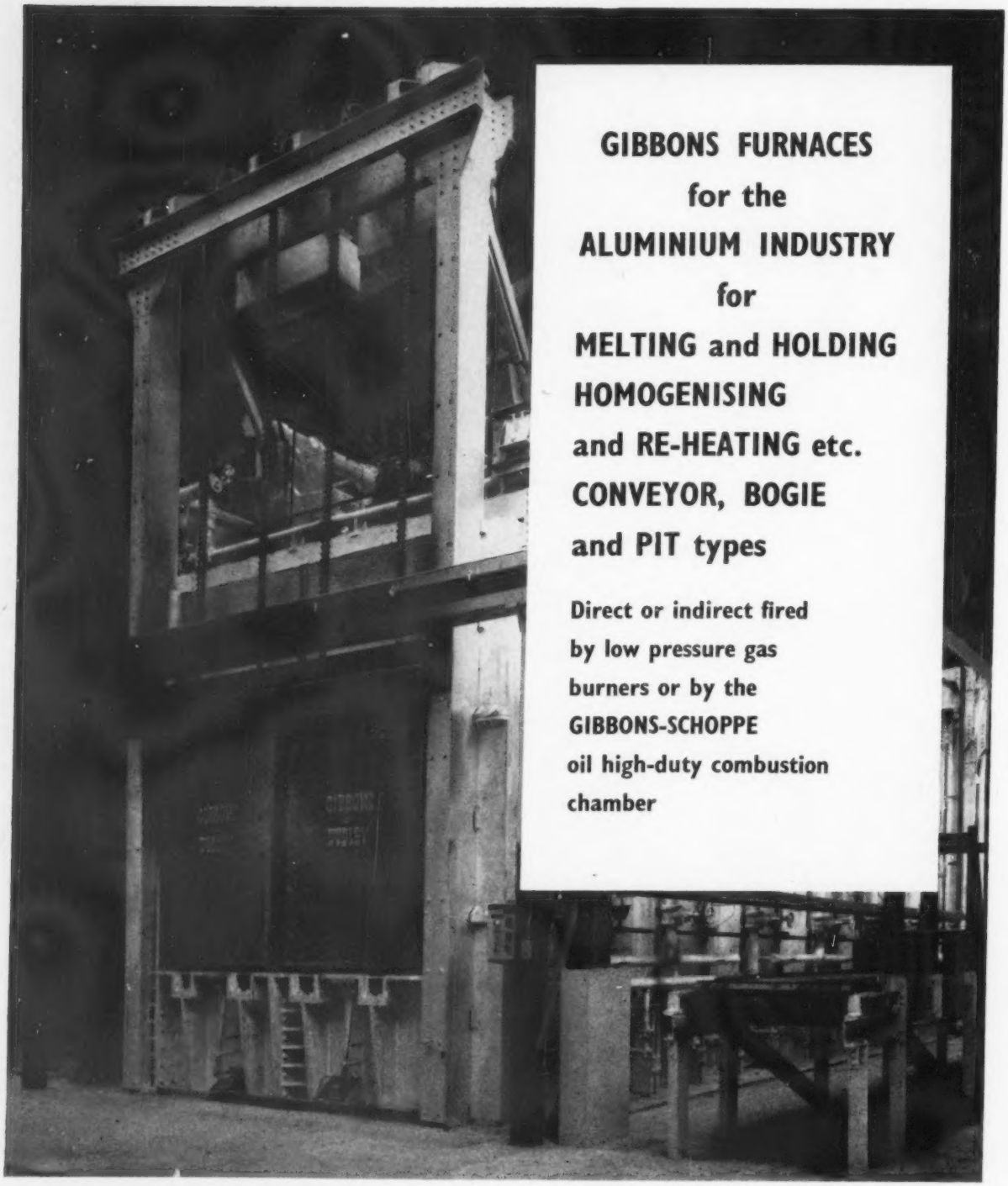

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METAL INDUSTRY

VOLUME 98 NUMBER 9 3 MARCH 1961

Tin Research

MANY interesting facts are contained in the Annual Report for the year 1960 of the International Tin Research Council, recently issued. In addition to reports of the Council and the Technical Committee, a considerable amount of information is given dealing with the current research work being carried out. Investigations on hot-dip and hot-barrel tinning of a number of typical small wares, such as tags, eyelets and washers, are continuing. The research on the continuous hot-tinning of narrow copper strip has been successfully concluded, and efforts are now being concentrated on steel strip. The resistance of various metals to the attack of molten tin and flux is being studied with a view to providing guidance on suitable materials for the construction of manipulating gear, molten metal valves, thermocouple sheaths, etc. A preliminary indication is that commercial-pure titanium shows great promise as a material resistant to tin and flux at temperatures in the neighbourhood of 300°C.

Some work has been undertaken on the diffusion processes controlling the formation of intermetallic compound layers on copper immersed in molten tin. When a copper specimen is placed in contact with molten tin saturated with copper, a compound layer forms and continues to grow by the process of diffusion. It has been observed, however, that the compound layer is also attacked by the liquid phase and, during small and local temperature fluctuations, copper is transported from the compound layer to the particles of intermetallic compound in the liquid solution. The Report states that a note on this is to be published.

Further work on the structural stability of the commercial tin-nickel electrodeposit has confirmed that changes in the crystal structure do not occur at temperatures up to 500°C. A study of the structure of electroplated alloys in the tin-lead, tin-zinc, tin-cadmium and tin-copper systems has also been completed. An important feature of the results is the difference found in the dispersion of the two component phases in systems which, metallurgically, are closely related.

In regard to aluminium-tin bearings, it was found possible to obtain and examine samples of solid aluminium-6 per cent tin bearings prepared from metal cast in chill-moulds and by the continuous casting process. The results of this work have been published. Another investigation which was completed in the year was that into the properties of titanium-aluminium-tin alloys prepared by powder metallurgy methods. The alloys were prepared from commercially available titanium powder and atomized tin powder, and aluminium was added either as aluminium powder or as the titanium-aluminium compound $TiAl_3$.

All the above items are dealt with at length in the Report, together with notes on tin-silver alloys, the continuous casting of bronze, high-melting intermetallic compounds of tin, and organotin compounds. The Report covers over 40 pages and is a clear exposition of the increasing value of the work of the Council.

Out of the MELTING POT

Some Details

AN article of not quite two short pages on the influence of copper and graphite on the properties of sintered iron-base bearings cannot hope to give more than some general, but nevertheless interesting, indications of some characteristics of this complex system. The compositions investigated ranged from 0·5 to 15 per cent copper powder (electrolytic) and from 0·5 to 3·5 per cent graphite, the balance consisting of reduced iron powder. Mixtures of these constituents were pressed under a pressure of 6 tons/cm^2 and then sintered at 1,150°C. in cracked ammonia. The porosity of the sintered specimens was 17·5-20 per cent. The tensile strength, elongation and Brinell hardness of the specimens were determined. The tensile strength of the sintered specimens increased rapidly with copper content at first, the addition of 1·5 per cent copper producing an increase of 50 per cent in tensile strength. Additions beyond 1·5 per cent copper produced only a slight further increase in strength, up to 15 per cent copper content. Most of the increase in hardness occurred as a result of additions of up to 5 per cent copper. Further increases were slight. There was only a slight reduction in elongation with increase in copper up to 1·5 per cent. When graphite was added, both the tensile strength and hardness increased to maximum values which were reached when 1·5 per cent graphite had been added and were followed by a reduction in both these properties with further additions of graphite. The sintered material with 1·5 per cent graphite consisted of pearlite or pearlite with a small amount of cementite. Copper, below 10 per cent, was present in the form of inclusions in the boundaries between the rounded pearlite grains.

Different Course

AS the name implies, semi-manufactured metal products are regarded as convenient starting materials from which more or less finished products can be manufactured. The line of thought involved is sufficiently familiar: the semi-manufactured product (sheet, extruded section, wire, etc.) should be chosen with a view to its manufacture into the finished product being possible by the simplest means and method. Like all familiar lines of thought, this one has the disadvantage of hiding less familiar lines. The latter, because they are less familiar, are, however, likely to prove all the more interesting and, without constituting broad highways for an easy and massive progress, might nevertheless be found worth following on certain occasions. They may be a little difficult to find. One way in which some of them may be discovered is by starting in a direction opposite to that taken by the familiar line of thought. The latter, for example, starts by seeking the most likely semi-manufactured product for the job in hand. Why not, therefore, start by looking for the most unlikely. Assume the part required looks as if it could be made quite readily by stamping from a small billet cut from an extruded section. Looking roughly in the opposite direction, could it not be made from foil, which could be crumpled, pressed and sintered to the required shape? Even if it most certainly could not, this little unusual mental exercise may well prove not wholly unprofitable. It may well suggest something else for which this unfamiliar method would be useful and, in addition, should conjure up thoughts of dispersion hardening by the included oxide films and/or the effects of other additives applied to the surface of the foil and crumpled up with it. Or, if not crumpled, the foil could perhaps be coiled or otherwise laminated for a start. Then again, going back to the start, thin wire might be another "unsuitable" starting material. Again, it might really prove unsuitable for the particular job under consideration, but might be discovered to hold out promise for other applications. Like foil, it could be crumpled or coiled, pressed and bonded into various configurations. Any other lines of thought?

Soluble Skeleton Cores

SEVERAL announcements made in recent years of processes for the production of foamed or aerated metals, mainly aluminium, have not been followed by more detailed accounts of the use of such processes in production and of the nature, properties and applications of parts made of foamed metals. This may confirm the original impression that the introduction of foaming agents into the molten metal, and the subsequent handling and control of the foamed metal, are difficult, or it may, of course, be only a reflection of the fact that applications of the processes and products are limited and quite possibly, moreover, "classified". A certain dissatisfaction is, nevertheless, suggested by the development of another method of producing porous or, as they are called in this case, cellular metals and castings. Unlike foaming, in which closed cavities are formed in the metal by bubbles of gas, this new method depends on the use of a "prefabricated" void structure in the form of a skeleton of a soluble solid into which skeleton the metal is cast and which is then removed by leaching. Most of the work so far has been done with aluminium, for which a skeleton of common salt of suitable particle size has been used. The cavity in a lined metal mould (for billets) or in a suitably faced sand mould (for shaped castings) is filled with the salt (shaking the mould if necessary). The salt-filled mould is then dried. During this process, condensation of moisture on the salt and its subsequent evaporation result in the bonding together of the particles of salt into a coherent skeleton. The mould is then preheated to assist penetration of the molten metal, and the salt skeleton is infiltrated with the molten metal. Depending on the size of the particles, and consequently on the pore size of the skeleton, infiltration may have to be assisted by the application of pressure and suction. Solidification must be controlled by suitable water cooling. In spite of the nature of the final product, the aim is to obtain a sound casting within the skeleton. Leaching of the latter is followed by rinsing to remove corrosive residues. A cellular metal casting having a void volume of approximately 70 per cent is obtained. Variations on the above include the production of metal castings with a permanent bonded skeleton (e.g. of graphite, silica, boron carbide) and the infiltration of cellular castings with another metal.

Skimmer

RECENT DEVELOPMENTS FOR THE NON-FERROUS METAL INDUSTRY

Oil-Fired Furnaces

By J. A. TAYLOR, B.Sc.(Eng.), A.M.Inst.F.

(*Fuel Oil Dept., Shell-Mex and B.P. Ltd.*)

A RECENT review of the use of liquid fuel in the metals industry[1] expressed the opinion that the major development in the period considered had been "in improving methods for obtaining temperature uniformity, especially with applications requiring relatively low temperatures".

This is of obvious importance to the non-ferrous metal industry, where generally lower temperatures than those in the ferrous field are encountered, and accounts for the successful application of oil in an ever-increasing number of processes.

Some of these applications and recent trends are reviewed in this article after an introductory consideration of developments in storage and handling of oil fuels.

Storage and Handling

The standard grades of oil fuel available in the U.K. and Eire are shown in Table I together with their physical characteristics and classification according to B.S.S.2869:1957. This Table, however, does not cover all grades available, and prospective users should consult reputable suppliers if certain characteristics conflict with their requirements for their particular application. It is also stressed that the figures quoted are specification limits; the actual fuel delivered will be within these limits. The most important items to be considered in oil storage and handling systems are pour point and viscosity, the former giving some indication of the minimum temperature at which the fuel may be stored and handled, the latter being a significant factor in calculating pressure drops in pipelines.

The pour point of an oil is defined as 5°F. above that temperature at which the oil does not flow in a glass, cylindrical, flat-bottomed test jar of specific size, which has been held horizontal for 5 sec., the oil being subjected to standardized heating and progressive cooling. The test conditions do not, in fact, give a true indication of conditions in a storage tank, where the fuel at the outlet is subjected to the static head of the fuel above, but, in the absence of a more significant test, it does give some indication of when the oil will cease to behave like a true liquid and, therefore, of the minimum temperature at which it should be stored.

In this country, the viscosity of an oil is usually measured in the Redwood No. 1 Viscometer, in which the time to discharge 50 c.c. of the liquid is measured under standard conditions. The test, however, gives results in quite arbitrary units of time (seconds) and it is considered a technical advantage to specify viscosity in kinematic units. It is noteworthy that B.S.S.2869:1957, entitled "Oil Fuels", quotes kinematic viscosity in its specifications for industrial and marine fuels.

The factors involved in the storage and handling of oil will not be discussed as these have been covered elsewhere[2]; however, a distinct development over the last decade has been the increasing use of outflow heaters in tanks using heavy grades. The advantages to be derived in using this type of heater are reduced heating costs (as the tank contents are maintained at lower temperatures than pumping temperatures) and reduced capital charges as the cost of lagging the tank is eliminated. It should not be taken categorically that outflow heaters are more economic for all heavy oil installations, but it can be stated that these grades may be stored satisfactorily at lower temperatures than was recommended some ten years ago.

The recommended storage and pumping temperatures for the standard grades are shown in Table II.

Outflow heaters can be supplied for use with steam or electricity or a combination of the two. They may be welded, bolted or flange mounted to the storage tank (Fig. 1).

A combined steam/electric heater is shown in Fig. 2, the heater consisting of a steel cylinder in which steam coils and an electric immersion heater with attendant steam regulating valve and thermostat are positioned. The inlet area should be at least twice the outlet area to ensure the heater is always flooded, and top vents are essential to ensure the heater does not become air-locked, particularly when first commissioned.

Apart from maintaining oil in storage tanks at the correct temperature, residual fuel oils must be maintained at the correct pumping temperature in the suction lines between tank and circulating pump and at the appropriate

TABLE I—STANDARD GRADES OF OIL FUEL

Grade	Gas Oil	Light Fuel Oil	Heavy Fuel Oil	Extra Heavy Fuel Oil
B.S.S. 2869 Classification	D	E	F	G
Viscosity Redwood No. 1 at 100°F. (Max.) (Seconds)	32/40	220	950	3,500
Flash Point (Pensky-Martens Closed Cup) °F. Min.	150	150	150	150
Specific Gravity at 60°F. (Approx.)	0·835	0·935	0·95	0·97
Pour Point (Max.)	15°F. Winter 20°F. Summer	35°F.	70°F.	70°F.
Gross Calorific Value (Approx.) B.Th.U/lb.	19,600	18,700	18,500	18,300
Therms/Gallon (Approx.)	1·64	1·75	1·76	1·77
Water Content per cent By Volume Max.	0·05	0·5	1·0	1·0
Ash Content per cent By Weight Max.	0·01	0·05	0·12	0·2
Sediment Content per cent By Weight Max.	0·01	0·1	0·2	0·25
Sulphur Content per cent By Weight Max.	1·0	3·2	4·0	4·0
Mean Specific Heat Between 0° and 100°C. Approx.	0·49	0·46	0·45	0·45

TABLE II—RECOMMENDED STORAGE AND PUMPING TEMPERATURES

Grade of Fuel	Storage Temperature °F.	Pumping Temperature °F.
Gas Oil	NO HEATING REQUIRED	
Light Fuel Oil	35	35
Heavy Fuel Oil	65	80
Extra Heavy Fuel Oil	75	110

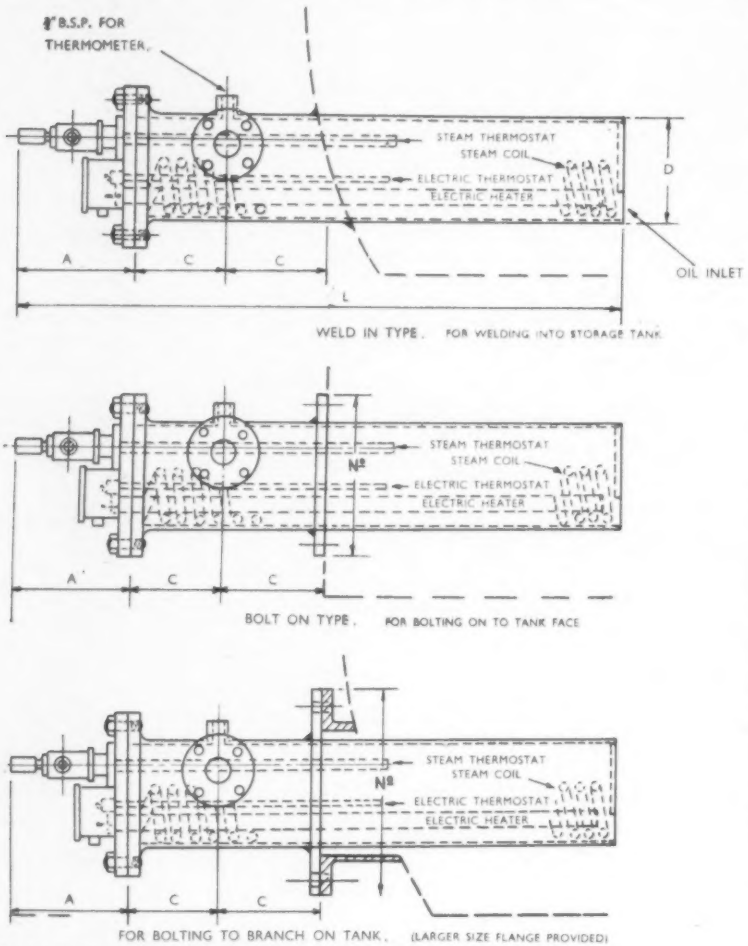
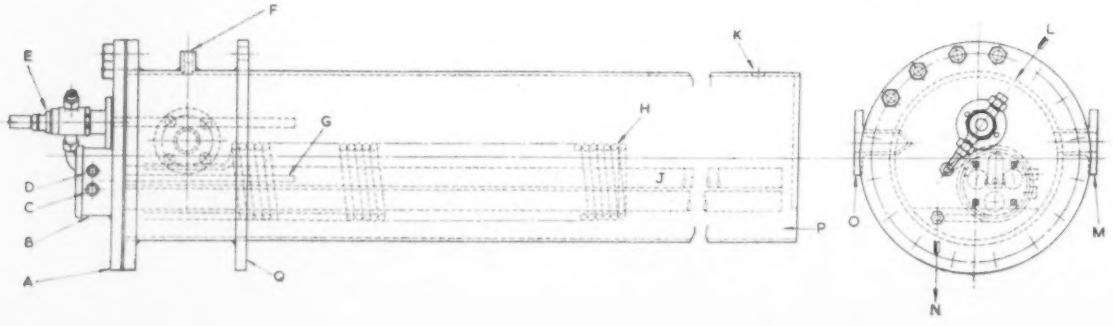


Fig. 1—Various arrangements for mounting out-flow heaters on oil storage tanks
Courtesy A. K. Waugh Ltd.]

Fig. 2—Combined steam/electric out-flow heater
Courtesy A. K. Waugh Ltd.]



temperature for which the ring main, to distribute the fuel to the various oil-fired equipment, has been designed. Where steam is available, tracing the oil line with a steam pipe is quite satisfactory, but there are cases where steam is not always available (particularly after a week-end shut-down) and alternative means of pipe heating must be employed.

In such cases, electrically heated tapes are widely used. These tapes consist of an insulated resistance element fitted to a flexible electrically insulated base forming a complete heating circuit terminating at one end. Being flexible, they are easily applied, and are particularly useful where a somewhat complicated system of pipes is involved.

On feed and suction lines, they are generally traced along the bottom centre of the pipe under 1 in. of lagging, whilst on ring mains they are traced on small bores under 1¼ in. to 1½ in. of lagging, and spiralled on larger bores under 1½ in. to 2 in. of lagging. Thermostatic control is used to keep the pipe at the correct temperature. Both traced and spiralled tapes are shown in Fig. 3 in position before the necessary lagging is applied.

Oil Burners

Control of excess air is axiomatic of good furnace design and is almost always incorporated in the more expensive large furnace. On the smaller, intermittent type of furnace, where it may well become an onerous capital item, it is at times insufficiently catered for. Such a furnace would be equipped with a simple low pressure air burner with separate controls for both oil and air and on such an installation it is common practice to leave the air setting at that suitable for the full firing rate and to obtain lower firing rates by turning down on the oil valve. In this way, with the burner set for full firing rate with 30 per cent excess air, at a turn-down of 3:1, the excess air becomes nearly 300 per cent at the low firing rate. Whilst the reduction in air required can be obtained on the burner, it involves the adjustment of two valves.

A—Header plate. B—Weathertight terminal cover. C—Heater cable. D—Control cable. E—Horne's patent steam valve. F—Connection for thermometer. G—Electrical thermostat. H—Steam coil heater. J—Electrical immersion heater. K—Vent hole. L—Steam inlet. M—Oil inlet. N—Exhaust. O—Hot oil return. P—Oil inlet (end plate cut away). Q—Flange for bolting to tank

A design which accomplishes this, using only single lever control, enabling constant air/oil ratio to be maintained throughout the firing rate, has obvious advantages. The self-proportioning, low pressure air burner achieves this by having the internals of the burner movable so that movement of the control lever changes the air flow rate through the burner as well as the oil rate. This provides for very simple control on multi-burner installations, the control levers of conveniently grouped burners being connected by linkages to a pulling motor or other controlling unit. Burners of this type are shown in Figs. 4 and 5.

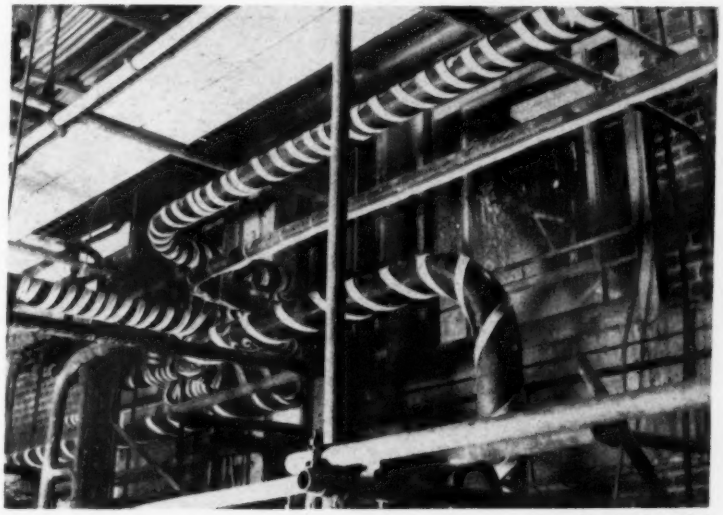
A low capacity medium pressure air burner was designed some years ago to operate at firing rates of ½ lb. of oil per hour or less and give a narrow-angled flame. Some installations, using a number of burners of this type, have shown that the "V" slot metering arrangement tended to give unequal flows to each burner because of partial valve chokage and the variation in pressure drop between burners being an appreciable proportion of the total head.

To overcome these difficulties, a new metering system has been designed, consisting of a vortex metering device similar to a spill-type pressure jet atomizer, supplied by a high pressure pump. Fuel spilled from the vortex chamber of the metering unit is piped back to the suction side of the pump and the output of the burner controlled by a valve in this line. This device has been tested and proven satisfactory for multi-burner installations.

High Intensity Combustion

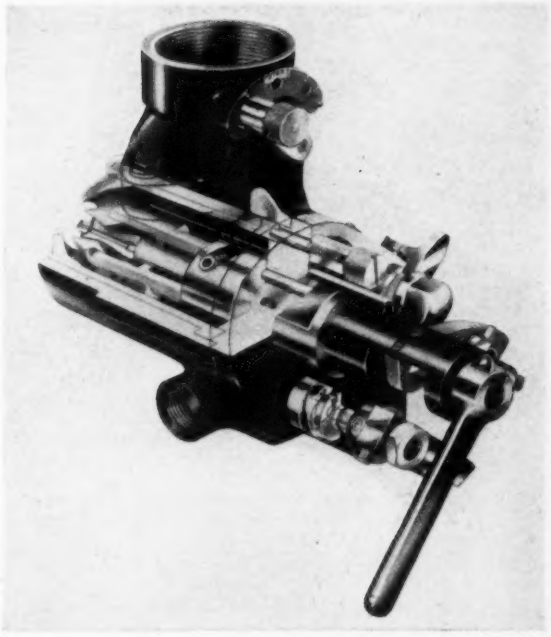
High intensity combustion chambers have been described previously, but development work has continued; two of the more recent additions to the market are the Urquhart toroidal and the Schoppe combustion chambers.

The Urquhart toroidal chamber is an application of aerodynamic toroidal rings to provide a system for obtaining intense burning of liquid fuels. A toroidal ring is inherently stable and persists strongly despite large variation in oil or air quantities. Consequently, the advantages of high intensity combustion and completeness of mixing are



[Courtesy Isopad Ltd.

Above: Fig. 3—Electrically heated tapes fitted to oil lines

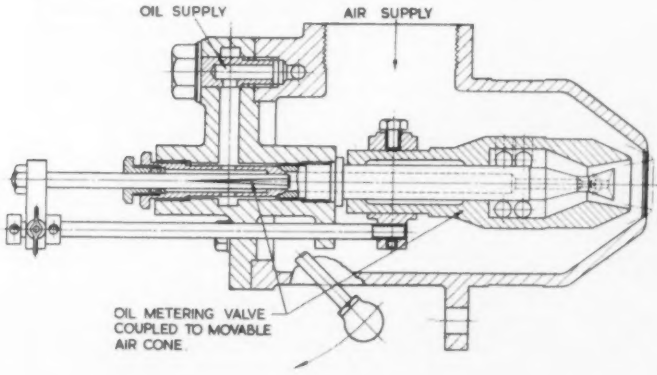


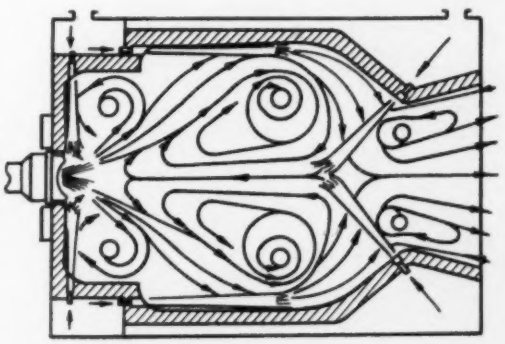
Right: Fig. 4—Self proportioning oil burner

Courtesy Nuway Heating Plants Ltd.]

Below left: Fig. 5—Self proportioning oil burner

Courtesy Schieldrop and Co. Ltd.]





Below: Fig. 6—Double toroidal combustion chamber

Courtesy Urquhart (1926) Ltd.

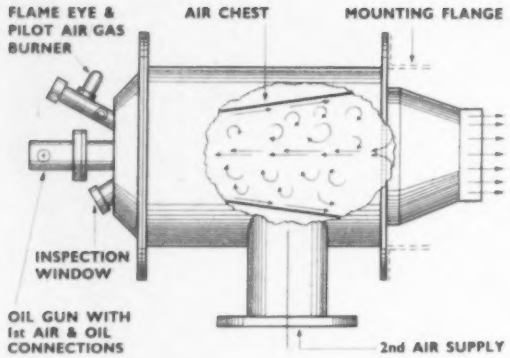


Fig. 7—Schoppe combustion unit

Courtesy Gibbons Brothers Ltd.]

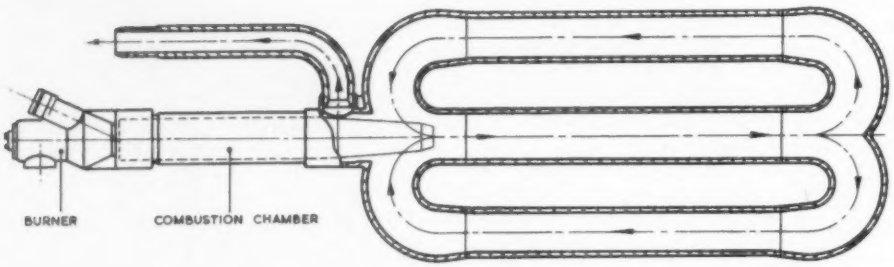


Fig. 8—"Jetube" oil-fired radiant tubes

Courtesy Incandescent Heat Ltd.]

retained through a wide range of turndown and air/fuel ratios.

The double toroidal unit (Fig. 6) has a combustion density of some 25 lb. oil/ft^3 which, due to the high degree of mixing obtained, is achieved with a pressure drop of only some 10 in. W.G. The design incorporates an air wash by discharging the jets along the walls before the air enters the flame. In this way, radiant heat from the flame is absorbed by the air, which, in many cases, has been calculated to reach 1,000°C. before it enters the flame and, in consequence, the wall temperatures are kept relatively low. Wall temperatures greatly in excess of 1,200°C. to 1,300°C. are not envisaged when operating down to some 30 per cent excess air. Tests carried out on these chambers have given Shell Smoke Numbers of 2 with 13 per cent CO_2 when using heavy fuel oil. Whilst smoke number readings do not give full indication of stack solids, it will be seen that this type of appliance is particularly suitable for applications where the products of combustion must be relatively free from unburned fuel.

Single toroidal units are based on the same principle, but are mainly combustors designed to give a short intense flame outside the combustor itself, and are very suitable for work where long flames cannot be tolerated. They are designed generally for exit gas velocities of the order of 6,000 ft/min.

The Schoppe unit (Fig. 7), covered by British Patent No. 760160, provides very wide limits of stability and hence high rates of thermal loading per unit volume. The flow system within the burner consists, in the main, of two patterns. The principal one is a toroidal vortex in the turbulent zone, in which the inter-reaction of fuel and air is accomplished, and the second, a more slowly moving layer of air travelling in a spiral path around the chamber casing. This layer mixes into the system at a relatively slow rate and has the very useful effect of cooling the chamber walls. It is possible, as a result, to avoid the disadvantages of refractory construction and its attendant maintenance cost. Frequently, the burner system is of all-metal construction.

The system is stable, not only over a very wide range of loading, but also against relatively high exhaust pressures, in some cases several atmospheres. Its range of usefulness, therefore, extends throughout the whole range of temperatures and pressures likely to be encountered in furnace engineering and power engineering, as in gas turbines, where it is adaptable to a wide range of recycling conditions.

A variation of these techniques is to allow only a portion of the combustion air to enter the combustion chamber, the remainder being passed into the heating chamber, where final combustion takes place.

This method (two-stage combustion) has been successfully applied in one or two instances in the ferrous field, but not, so far, to the author's knowledge, to non-ferrous processes. It permits "softer" flame conditions such as obtained with gaseous combustion and provides for close control of furnace atmosphere.

Radiant Tubes

In the non-ferrous metal field, perhaps, one of the most significant developments has been the oil-fired radiant tube.

One of these designs, the "Jetube", has either two or three legs according to heat requirements, and is manufactured in either cast or fabricated nickel-chrome steel. Sizes range from 3 in. to 6 in. diameter; they can operate with surface temperatures ranging from 200°C. to 1,100°C. and rates of heat transfer obtained range from 3,000 to 10,000 B.Th.U/ft^2/hr. A medium pressure air burner with forced secondary air casing is used to give a turndown ratio on the burner of 5:1.

A cross-section through a three-legged radiant tube is shown in Fig. 8, from which will be seen the disposition of the combustion chamber and exhaust legs in relation to the main tubes. Up to 2 gal/hr. of distillate fuel is completely burnt in the combustion chamber, which is lined with a high grade refractory. The hot products of combustion issue from an orifice into the centre tube with a velocity of the order of 500 ft/sec. By this means, high rates of heat transfer to the tube are achieved, as is recirculation of the products of combustion, which provides even temperature distribution throughout the tube length. A distillate grade of fuel is used, principally because of the low firing rates, tube life being dependent upon operating temperatures and furnace atmosphere. Experience so far, has indicated tube lives in excess of 30,000 hr. when operating at 700°C., in excess of 20,000 hr. at 920°C. and in excess of 10,000 hr. at 1,050°C.

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[1] E. Brett Davies and A. B. Pritchard; Proceedings of the Second Liquid Fuels Conference, Institute of Fuel, 1959, May.

[2] T. Chippindale; *J. Inst. Heat. and Vent. Eng.*, 1957, April.

(To be continued)

Creep Data

CREEP and rupture properties of conventional high-temperature materials are now being collected and tabulated at the Creep Information Centre at the National Engineering Laboratory of the D.S.I.R. Some British manufacturers have already sent in details of their standard materials. In due course, high-temperature data for British materials will be issued in an agreed form, although commercial security may restrict publication of some of the data.

Later, it is hoped to extend the scheme to cover all mechanical properties of British materials for use at elevated temperatures, to collect details of testing machines and test procedures, and also to obtain information about foreign materials and equipment. It is hoped that it will become the national centre for information on the mechanical properties of materials for use at elevated temperatures.

Finishing Supplement

Organic and Metallic Finishes

By R. J. BROWN, A.I.Mech.E., F.I.M.

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In the automobile industry much depends upon the durability and attractive appearance of the finishes applied. This article, which is based on a Paper given before the Sheffield and North-East Branch of the Institute of Metal Finishing, reviews the requirements such finishes have to meet, the tests by which they are assessed and the service conditions encountered.

WHATEVER product a customer purchases, he is entitled to expect from it an adequate standard of performance. What is meant by the term "adequate performance standard" is dependent upon a number of factors, and, so far as the automobile industry is concerned, the term "service life" means different things to different people. Some purchasers of a motor car might expect the vehicle to outlast their lifetime, but such a demand does not take into account the fact that styles in motor cars change. In the industry itself the aim is to produce a saleable and efficient product which will give useful service life without unnecessary expenditure on maintenance.

The modern car in its normal service life is subjected to extremely arduous conditions. This may involve the shipping of the complete vehicle for many thousands of miles during which climatic conditions will vary within extremely wide limits; in the day to day life of the vehicle the many finishes which are incorporated are exposed to the effects of weather and fluctuating temperatures. Even in this country fluctuations in temperature in the summer season can vary quite widely, whereas at other seasons the climatic conditions are such that temperature variations result in almost continual condensation of moisture on the body surface. The normal climatic hazards are aggravated by the effects of industrial atmosphere, and these may vary from high concentrations of abrasive and corrosive solids to high concentrations of dissolved gases in the deposited moisture resulting from pollution of the atmosphere with the gaseous products of industrial life, particularly sulphur dioxide. Normal climatic conditions in themselves bring about differing dimensional effects in the coating material and in the substrate to which they are applied, and this may have the effect of reducing the adhesion at the interfaces of the different layers, and can in some conditions actually produce cracking of the applied finishes.

From this brief consideration it will be realized that it would be impossible to lay down a guaranteed service life for the finishes applied to motor vehicles for all conditions of service, and, in addition, one must take into account the varying degrees of maintenance which are likely to be applied by the owner of the vehicle.

Organic Finishes

It will be no disadvantage to consider first the object of using organic finishes. Whilst their origin is probably unknown, there is evidence of their use in early historical times, but for decorative rather than for protective purposes. The purpose of an organic finish, whether it comprises a single coat or a combination of coatings, will have either one or a combination of the following objectives:—prevention of corrosion; filling in of surface blemishes; provision of an attractive permanent appearance, by colour and by surface texture.

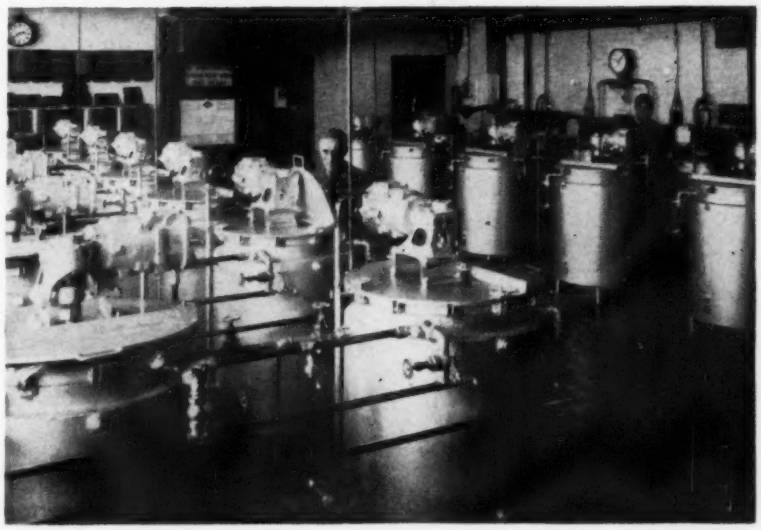
In the case of the motor car, surfaces which are hidden or not generally visible are given an organic finish for protective purposes only, whereas the visible finish has all three of the above objectives in view.

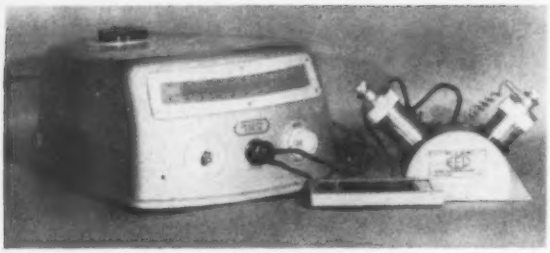
Organic finishes, apart from variations in type, vary also in the method by which they are applied; they may comprise a single layer, or a multiplicity of layers, according to the purpose of the coating, and thus, in the testing of organic finishes, not only are the properties of the individual coats of importance, but also their inter-relationship and the performance of the combination of coatings.

Very little of value has been published on the subject of performance testing, so that the user is in an extremely difficult position, and this has led to a lot of exploratory work prior to the setting-up of a rational system of testing. The paint user is denied by the paint manufacturer detailed information on formulation, and the necessary chemical and physical analyses to determine formulation are not only difficult and prolonged, but also require the availability of most expensive scientific apparatus and equally expensive specialist staff, these being generally beyond the realm of possibility on the part of the users, however large they may be.

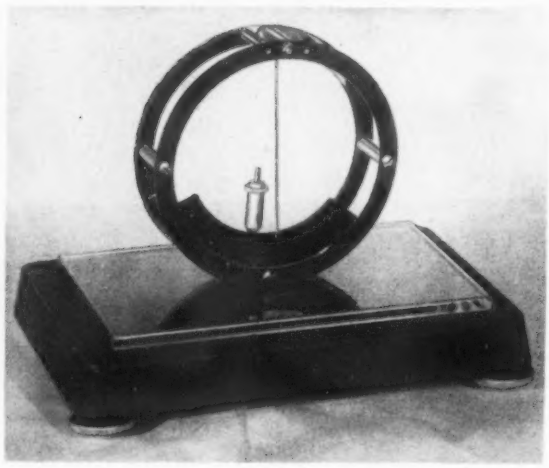
One cannot help drawing a parallel between the attitude of the paint manufacturer and the attitude of the steel maker in the early part of the century; at that period, steels were broadly classed and sold under trade names, great secrecy being maintained about composition. Fortunately, a better understanding has been achieved over the years, and close control of the product is now possible by both steel maker and user. In the organic finishing industry the position is certainly more involved than in the case of the steel industry, and purchase of material to composition, at least on a national basis, or possibly even on an

Fig. 1—General view of a paint mixing station





Left: Fig. 2—The EEL Glossmeter



Right: Fig. 4—The Sward-Rocker apparatus for determining hardness of paint finishes

industry basis, would be unwise, although not necessarily impossible. However, the user is primarily interested in the performance of the final coating and in those tests which will ensure satisfactory application in the factory, but he is surely within his rights in expecting to be supplied with information on the formulation of the product he buys.

The performance requirements of organic finishes vary widely according to the service location, and it is worth while comparing the user's expectation of the life of organic finishes as between those applied in the home and those applied to an assembly such as the motor car. In and around the home it is normal and accepted practice that decorations have to be renewed, be it inside or out. This renewal is often considered unnecessary but desirable, in order to provide a change of colour scheme, but if the same yardstick of inspection was applied in the home as in the case of the motor car, how essential that renewal would be, often after so short a period as one to two years, owing to the presence of blisters in the paint work, peeled areas adjacent to condensing surfaces, rust stains adjacent to metal work, etc. Because the finish is so often applied over timber, and because re-finishing is an accepted procedure, an annual average expenditure of anything from £10 to £30 or so is not considered unusual even for a modest home. But if re-finishing of a motor car, produced not in timber but in an extremely corrosive material and subject to extremely severe service conditions, becomes necessary within a period of, say, five to ten years, loud are the complaints of the owners. It must be agreed that finishes used by the motor industry are certainly not perfect, but nevertheless considerable pride is taken in the fact that they are more nearly perfect, both in appearance and serviceability, than are the finishes applied in most other industries, and they certainly represent to the car owner very good value for money.

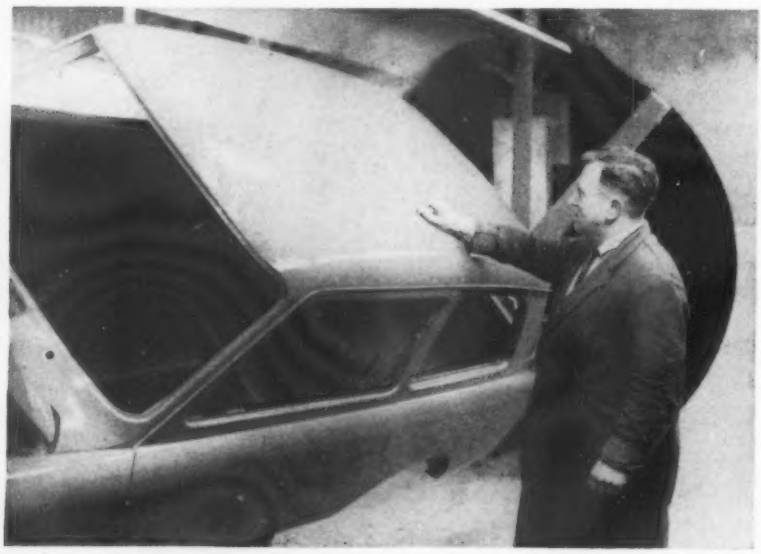
Climatic conditions on the earth's surface vary widely, this having a pronounced influence on service life. Temperatures throughout the world may vary from −40° F. up to 200° F., with humidity from almost nil up to 100 per cent and ultra-violet radiation from mild to intense. Apart from these variations, conditions fluctuate throughout any 24 hr. period, such that gross condensation may occur on the cool body surfaces during the night hours and be slowly or rapidly dispelled, followed by periods of intense ultra-violet and infra-red radiation, and it is these conditions which are known to promote the most rapid breakdown of organic finishes.

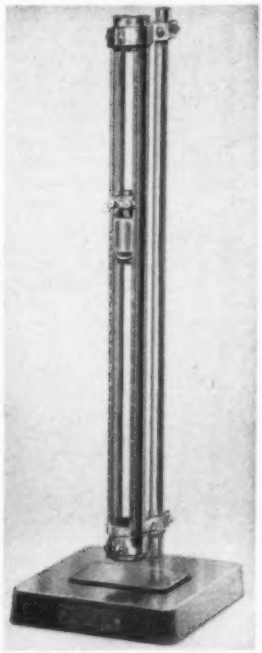
The type of tests applied to organic finishes will obviously vary with the purpose of the finish; thus, finishes applied to the engine must withstand the effects of heat, of fuel, of oil, and also of detergents used in engine manufacture, whereas those applied to the visible body surfaces must withstand abrasion, impact, the effect of petrol, oil, tar, etc., and also prolonged weathering without deterioration, visible or invisible. This is probably the place to consider the variety of organic finishes found in a motor car, these being:—(1): (a) engine finishes—external application, (b) crankcase sealers—internal application; (2): chassis finish—preferably stove enamel; (3): primer finish—for invisible panel surfaces; (4): exterior finish—generally a multi-coat system; (5): wood finish—external for ash framing; (6) wood finish—for internal veneered trim; (7): high-temperature finishes for silencers and exhaust systems.

Acceptance tests normally applied are: (a) viscosity and thinning ratio; (b) shade and gloss of finished test panel.

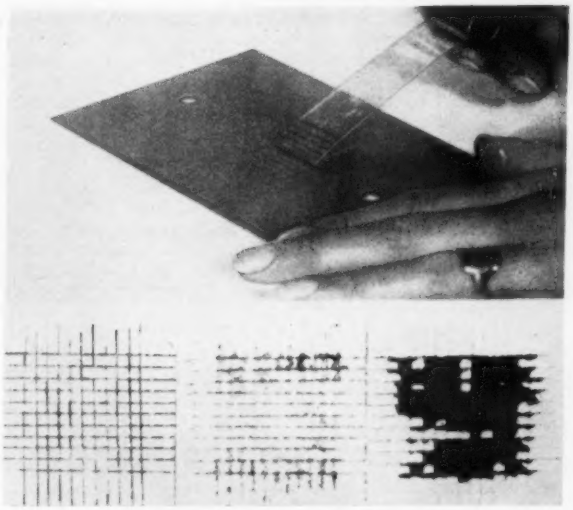
Viscosity is determined by conventional methods using a flow-cup in accordance with the requirements of B.S.1733; the thinning ratio provides a degree of control over the consistency of incoming supplies and enables any necessary adjustments to be made at the mixing station (Fig. 1). The preparation of a spray-coated panel in the paint laboratory not only provides the means of assessing the correctness of shade, but also of flow-out. While these assessments are normally made subjectively by eye, use is made of the

Fig. 3—Marking up areas requiring rectification on a car body





Right: Fig. 5—Apparatus for impact adhesion test



Left: Fig. 6—Peeling adhesive tape from a cross-hatched test panel (top) and examples showing paint torn away at intersection of scored lines

EEL Glossmeter (Fig. 2) or equivalent apparatus. As a further check of consistency, total solids may be determined, and also the pigment/vehicle ratio. These tests have as their object the maintenance of a uniform supply of paint to the paint shop, and they follow the initial acceptance of any given paint which has been based on a much more thorough system of testing, which will be described later.

Product inspection is applied at each stage of coating, in order to ensure that the final finish provides as near perfect a surface as may be possible. Inspection is aimed at eliminating faults in the metal work, such as dings, as well as faults in the application of the coatings, such as runs and dry spray. The basis of any paint system is that it shall not only provide protection against corrosion and the deteriorating influences of the atmosphere, but that it shall have the ability to fill in small surface defects such as discing marks. It is against the possibility of such defects that constant visual inspection is so necessary at all stages, areas requiring rectification being marked up (Fig. 3) and subsequently wet rubbed, followed by the requisite re-spraying of the affected areas before proceeding to the next full coat.

The thickness of the coating is one of the most important requirements in any paint finish which is required to have durability, and, in particular, blister resistance. In a product such as a motor car body, reasonable coating thickness is, in any case, necessary in order to achieve the desired standard of finish, but care has to be exercised in order that those areas which have, of necessity, been vigorously rubbed down and locally sprayed-in during the undercoating processes, finish up with the minimum required thickness, which for a stoving finish is generally considered to be of the order of at least 0·045 in.

Assuming that the finished coating meets the requirements of the production paint laboratory for colour, application and retouching characteristics, consider now the properties it is required to possess. These are (1) satisfactory appearance—(a) gloss of the required degree, (b) freedom from blemishes, (c) hold-out (or resistance to sinkage); (2) hardness; (3) adhesion; (4) flexibility; (5) corrosion resistance; (6) chip resistance; (7) weathering resistance.

Appearance—This is judged subjectively on the basis of a fully finished test panel incorporating each of the undercoating materials which are considered necessary. Gloss is normally assessed by comparison with reference panels, but in doubtful cases use would be made of the EEL Glossmeter. The degree of gloss in a finish is a matter of individual choice. In the motor industry there are two schools of thought, one of which requires as glossy a finish as possible whereas the other considers a slightly lower gloss to be more acceptable in that this is more comparable with the finish obtained with cellulose lacquers, which have to be hand polished and have a relatively perfect surface. Freedom from blemishes is also judged by eye, and these may result from faults in paint compounding; the use of a low power binocular microscope is an advantage if those blemishes are of a minor degree. The ability of the paint to fill in microscopic irregularities, such as fine sanding marks, is also noted.

Hardness—While a measure of hardness is required in all the coats of a multi-coat system, it is more important in the final coat than in the undercoats; the workshop method of testing is to use the thumb nail, or the graphite pencil, but for the evaluation of fresh supplies of material more precise tests are considered necessary, and the most widely used is probably the scratch hardness test, as described in DEF/1055. Another quite widely used method of determining hardness is the Sward Rocker apparatus[1] (Fig. 4), in which a pendulum is suspended between two circular rockers and the number of swings recorded from a constant amplitude until the oscillations diminish to an amplitude which is equivalent to that obtained after 50 swings of the instrument on plate glass. A more precise test is indentation hardness on the classic principle devised by Brinell; a piece of apparatus built in our laboratories some years ago for this purpose makes use of a standard Vickers pyramidal indentor and a Vickers microscope for measurement of the impression. Not only has this method of hardness determination been of considerable value in assessing competitive paints, but it has also enabled a survey to be made of the hardness change which occurs on weathering, which can be appreciable and may be related to the service behaviour of the finish in question. The indentation test overcomes criticisms which can be levelled against the scratch hardness test: that it is not sufficiently precise and that the result is affected to some extent by the adhesion and elasticity of the coating; and against the rocker apparatus that it more truly records the resilience of the film.

Adhesion—This property is generally determined by the impact adhesion test similar to that described in DEF/1053, in which a small tup with a hemispherical indentor is allowed to fall freely by gravitation on to the prepared test pieces, with the coated surface down (Fig. 5). The depth of the dome or cup produced in the test is determined by means of distance pieces placed between the crosshead and the die block, the comparative adhesion being the dome size at which the paint is readily removed with the finger at the tip of the dome. The

Erichsen or Olsen cupping test is also widely used, the dome produced in the test piece being developed slowly in comparison with the sudden formation by the impact test, and a single test enables a rapid comparison to be made between samples, whereas in the impact test a series of tests is necessary. Neither test provides a fair measurement, even comparative, of adhesion alone, in that the performance of the film depends also upon its flexibility, its ductility and its strength. It might be possible for a coating with a very high degree of adhesion, but having low intrinsic strength, to give very low results on either of these tests. Possibly the most valuable adhesion test in fairly general use is the cross-hatch test[2] (Fig. 6), in which the coating is cut through, either with a sharp knife or in a press, with a series of parallel lines about $\frac{1}{8}$ in. apart and at right-angles to one another. A rough comparison of adhesion can be made using the thumb nail or a coin, or a more precise comparison made by pressing adhesive tape over the cross-hatch surface and then suddenly peeling it away, preferably in a jig (Fig. 6, top). The hatched test panel may also be deformed by cupping and relative adhesion assessed. A particularly interesting method of measuring adhesion has been described by May, Smith and Snow,[3] a disc of paint being separated from the substrate by shooting the prepared specimen against a rigid stop, a measurement being made of the force at which this disc of paint was detached. Unfortunately, this technique does not appear to have been adopted to any extent judging by the absence of published data, apart from those of the authors.

References

[1] A. J. Birch; *Prod. Finish*, 1956, Jan.
[2] G.E.C. (U.S.A.), Test Method, E9B5—S1.
[3] W. D. May, N. D. P. Smith, C. I. Snow; *Trans. I.M.F.*, 195657, **29**.

(To be continued)

Men and Metals

It has been announced by the British Iron and Steel Research Association that **Mr. H. F. Spencer**, managing director of Richard Thomas and Baldwins Limited, has accepted the appointment as President of the Association in succession to the late Sir Charles Bruce-Gardner.

News from E.M.B. Company Limited is that **Mr. R. S. Montgomerie**, their London area manager, is to retire at the end of next month owing to indifferent health. He will, however, continue to serve the company on a part-time basis. His assistant, **Mr. P. N. Jay**, will become the London area manager.

It is reported from Detroit, U.S.A., that the Society of Die Casting Engineers have elected the following officers for 1961:—President, **Mr. John L. MacLaren**; vice-president, **Mr. Earle W. Rearwin**; secretary, **Mr. M. R. Tenenbaum**; and treasurer, **Mr. Lee G. Axford.**

Resigning from his position of secretary to the British Electrical and Allied Manufacturers' Association, **Mr. James Oldroyd**, T.D., M.A., F.C.I.S., has been appointed general manager of the Lead Development Association and will take up his new appointment next month.

Appointed head of the engineering section of the British Steel Castings Research Association, **Mr. P. Lambert**, A.M.I.Mech.E., joined the association's staff in September 1955 as a senior investigator in the plant engineering section.

New district managers for the sales team of Venesta Foils Limited have recently been appointed. **Mr. M. P. Keenan** has assumed responsibility for the sales of, primarily, milk capping strip in a north-to-south district extending from Lincolnshire through Leicester and Cambridge to Hampshire. **Mr. M. Wise** will deal with all foil materials for Yorkshire, Cheshire, Shropshire, Derbyshire and Notts. **Mr. B. Hoole** will be responsible for sales of all foil materials other than milk capping strip in West and South-West London, Hertfordshire, Middlesex, Surrey and Hampshire.

It is understood that, due to increased business commitments, **Mr. G. W. H. Richardson** has resigned as a director of Westinghouse Brake and Signal Company Limited.

It is reported that **Mr. J. D. St. C. Oliff-Lee** has been appointed a director of the Metal Market and Exchange Company.

Associated with Barfield and G.W.B. Furnaces Limited for the past twelve years, **Mr. L. G. W. Palethorpe** has recently taken up an appointment with Salem-Brosius (England) Limited as manager of their heat-treatment division.

President of the Canada Life Assurance Company, **Mr. E. C. Gill** has been elected a member of the Advisory Committee of the International Nickel Company of Canada Limited.

At present deputy chairman and managing director of Crofts Engineers (Holdings) Limited, **Mr. John Arthur Croft** has now been appointed chairman of the company and its principal operating subsidiary companies.

For the first time, Diplomas in Technology have been awarded to women students at Birmingham College of Advanced Technology. **Miss Janet Moulson** and **Miss Judith Hunter** were the successful ladies, and both are assistant technical officers at the Metals Division of Imperial Chemical Industries Limited.

It is understood that **Mr. Peter Jardine** has been appointed managing director of J. G. Statter and Company, and Minerva Mouldings, both members of the Metal Industries group.

At the Spring Meeting of the Institute of Metals, to be held in London from March 21 to 23, the May Lecture is to be given by **Professor M. Polanyi**, D.Sc., F.R.S., on the evening of Tuesday, March 21. The lecture will be entitled "Science: Academic and Industrial". The meeting will be held at The Royal Institution in London.

Electro-Refined Titanium

STRENGTH and hardness of electro-refined titanium-base binary titanium-oxygen (0·034-0·20 weight per cent), titanium-nitrogen (0·006-0·087 weight per cent), and titanium-carbon (0·033-0·12 weight per cent) alloys using electro-refined titanium are linear functions of alloy content. Investigations at the U.S. Bureau of Mines indicate that the strength is approximately 10,000 lb/in^2 lower than values reported for iodide titanium-base alloys. Lower strength and hardness are attributed to lower initial total impurity content of the electro-refined metal. Elongation values of the electro-refined titanium-base alloys are similar to iodide titanium-base alloys similarly processed, with decreasing ductility for increasing impurity contents.

Hardening and strengthening trends are similar to those reported for iodide titanium and commercial Kroll sponge-base alloys. Compared to oxygen and carbon, nitrogen is the most effective strengthener and hardener, followed by oxygen, then carbon. In the composition range, where carbides are present (above 0·10 weight per cent carbon), strength and hardness of titanium-carbon alloys increased only slightly.

Iron appears to be a more effective strengthener of titanium than carbon, but its effects are attributed to the presence of transformed beta in the structure. For equivalent hardness levels, the strengths of titanium-iron alloys are from 5,000 to 8,000 lb/in^2 greater than for binary titanium alloys with oxygen, nitrogen, or carbon.

INFLUENCE OF DIFFERENT METHODS FOR MAKING ADDITIONS OF PHOSPHORUS

Hyper-Eutectic Aluminium-Silicon Casting Alloys

By S. J. ASHTON, M.Eng., A.I.M., J. MUIR, L.I.M. and W. M. DOYLE, Ph.D., M.Eng., F.I.M.

(*Research Division, High Duty Alloys Ltd., Slough*)

(*Concluded from* METAL INDUSTRY, 24 *February* 1961)

EXPERIMENTAL results derived from refining melts of the hyper-eutectic aluminium-silicon alloy EX.451 with phosphorus, added by various means, and of the work to isolate the factors influencing the efficiency of the nucleation, are consistent with the hypothesis that the phosphorus combines with the aluminium to form solid particles of aluminium phosphide which are stable at the processing and casting temperatures. The aluminium phosphide particles serve as nuclei on which the primary silicon phase crystallizes when the melt is cooled quickly from a temperature above the liquidus, resulting in a final microstructure with small, evenly distributed, primary silicon crystals.

If the melt is cooled slowly, a comparatively small number of primary silicon particles will crystallize out at the liquidus temperature. If this cooling rate is continued, the bulk of the remaining primary silicon will crystallize on the silicon particles already formed, in preference to the aluminium phosphide nuclei. This will result in the observed, badly nucleated structures with coarse silicon crystals.

The same mechanism applies also when a hyper-eutectic aluminium-silicon melt is cooled rapidly from a temperature below the liquidus, when some primary silicon crystals will be present before the chilling is commenced. In this case, however, some of the silicon will probably crystallize on aluminium phosphide nuclei with a resulting wide variation in particle size in the final casting.

It has been found that within the range of die-cast sections examined. i.e. ¼ in.-1 in., the distribution and size of the primary silicon phase were not significantly affected by section thickness. It is expected that in thicker section die-cast components, the primary silicon particle size, although probably being slightly coarser, will still be acceptable. If it is not practicable or economic to die-cast the alloy, sand-castings with satisfactory structures can be produced as long as the chilling properties of the sand adjacent to the critical areas of the components are increased. This latter effect can be achieved either by the extensive use of chills or possibly by making thermal conducting additions to the backing sand and using a facing sand for surface finish purposes.

Of the three methods investigated for the introduction of phosphorus to the melts, treatment with ferro-phosphorus alloy tablets has several definite advantages. First, the tablets are easy to use and do not give rise to any objectionable fumes. Secondly, the total phosphorus content in the final castings can be predicted with much more certainty and, thirdly, although the tensile properties of the components show no advantage over those refined with EP1136 and Nucleant 10, the primary silicon crystal size is smaller.

It has been ascertained that the total phosphorus contents to give the optimum balance between tensile properties and microstructures for ferro-phosphorus, Nucleant 10 and EP1136 were similar, being 0·012, 0·015 and 0·016 per cent, respectively. The corresponding "insoluble" phosphorus values were of the order of 0·009, 0·01 and 0·013 per cent, respectively. All these values show satisfactorily close agreement with the optimum phosphorus contents, presumably total, of 0·01 per cent quoted by other investigators (Kessler[4] *et al*).

It is logical that the tensile properties of a well nucleated structure should be independent of the method of addition of the phosphorus, but the reason for the smaller primary silicon particle size, produced by the use of ferro-phosphorus tablets is less obvious. A tentative explanation lies in the method of preparation of the tablets and their introduction into the melt. The ferro-phosphorus grains are extremely fine, and when a tablet sinks in the liquid aluminium under its own weight, the flux starts to decompose and, momentarily, a high pressure is built up within the container. A mild explosion then occurs which scatters the wetted grains throughout the melt. This results in a large number of very fine, widely dispersed nuclei being formed. In both the Nucleant 10 and EP1136 tablets, the phosphorus is in elemental form, which should be more reactive and, theoretically, should produce a greater degree of nucleation. However, it is suggested that when these compounds are introduced into the melt, the design of the plunger, which it is necessary to employ to retain the tablets at the bottom of the melt, prevents, to some extent, the free dispersion of the aluminium phosphide nuclei into the bulk of the melt. A certain amount of agglomeration will occur with the formation of fewer, larger nuclei and a concomitant decrease in effectiveness of refinement.

The fact that the tensile strength increases progressively with total phosphorus content up to about 0·010-0·015 per cent (see Fig. 1) and above this level no further improvement in strength is produced, requires explanation. To understand the reasons for this, it must be appreciated that all the total phosphorus content does not necessarily take part in the nucleation of the primary silicon phase. When the "insoluble" phosphorus content, i.e. the part directly associated with the silicon, is plotted against the total content, as in Fig. 13, it will be seen that when 0·010-0·015 per cent total phosphorus has been introduced, further additions result in very much smaller increases in the "insoluble" content. Thus, when 0·010-0·015 per cent total phosphorus has been added, further amounts will not produce a significant improvement in refinement and cannot be expected to affect the level of tensile strength. It appears that when EX.451 melts are prepared under comparable conditions, the primary silicon particles in the resultant castings will be of similar size, which means that the number of aluminium-phosphide nuclei required in each case will be of the same order.

This conclusion is confirmed by the work with the ferro-phosphorus in which castings with 0·012 and 0·101 per cent total phosphorus showed a similar primary silicon particle size. However, increasing the total phosphorus content of castings refined with Nucleant 10 from about 0·030 to 0·062 per cent resulted in appreciably coarser primary

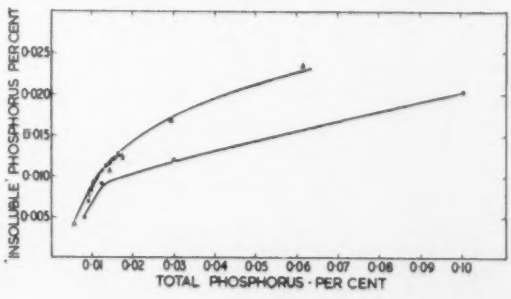


Fig. 13—Relationship between "insoluble" phosphorus content and total phosphorus content for die-cast bars

silicon crystals. The reason for the difference in behaviour between the comparatively large amounts of phosphorus introduced by Nucleant 10 and ferro-phosphorus is thought to be that the nuclei added by the latter means are more widely dispersed and agglomeration is less likely to occur than in the case of the Nucleant 10, which is introduced by means of a plunger. Confirmation of this theory lies in the fact that much greater losses occur during the introduction of phosphorus by EP1136 and Nucleant 10 than by the use of ferro-phosphorus. This is partly due to the burning which occurs in the former cases, but also to the aluminium-phosphide nuclei coalescing to such an extent that they float to the surface and are removed during the processing, particularly during the ensuing degassing stage.

The very slight progressive coarsening which results from prolonged holding of the melts at 800°C., or repeated remelting of the alloy, is also due in part to agglomeration of the aluminium-phosphide nuclei and, to some extent to the removal of a proportion of the nuclei into the flux cover. In addition, some of the phosphide particles may be rendered ineffective by chemisorbtion of impurity atoms on the surfaces.

Of the four degassing media investigated, chlorine was the most effective, but it is realized that the attendant difficulties with the use of this gas will prevent most foundries from adopting this technique. If this is the case, degassing with Foseco 450 tablets (12 oz. per 100 lb.) would appear to offer the next best solution. Treatment with nitrogen, although being fairly effective, has the disadvantage that somewhat similarly to chlorine, prolonging the treatment results in a coarsening of the primary silicon particles. This is probably due to the removal of a large number of the aluminium-phosphide nuclei by "flotation" during the extended passage of the gas through the melt.

The degassing achieved by the addition of Foseco 190 was considerably inferior to that produced by treatment with Foseco 450 tablets. This appears to be due to the full potential of the hexachlorethane in the former product not having been realized, due to the necessity of adding these tablets by means of a bell plunger. The magnesium chloride formed from the magnesium in the melt cannot escape freely into the melt as discrete, fine bubbles, as is the case with the refractory-based Foseco 450 tablets held freely on a hooked rod, but tends to accumulate under the plunger and is released into the melt as larger bubbles. The surface area of the bubbles thus available for the gas in the melt to diffuse into is greatly reduced.

The coarsening of the primary silicon phase by contamination of the melts with sodium is due to the latter combining with the phosphorus-containing compounds, with the consequent reduction in the number of effective aluminium-phosphide nuclei. If there is an excess of sodium after the reaction with the phosphorus compounds, this will result in the matrix solidifying, not as acicular eutectic, but in the characteristic form of aluminium dendrites and rounded eutectic silicon particles.

It appears from the evidence gained during these and other experiments and the production of various components, including die-cast cylinder barrels and sand-cast cylinder blocks, that the casting characteristics of the hypereutectic aluminium silicon alloy EX.451 are quite satisfactory if certain precautions are taken and the melts are processed correctly. The properly nucleated alloy feeds fairly well, but it has been noted that poorly nucleated melts show a tendency towards sluggish flow, presumably due to the coarse primary silicon particles interfering with the flow of the metal into the die. The alloy is not prone to hot tearing and with the use of fairly short, wide risers and short pouring passages, a negligible amount of trouble has been experienced with micro- and macroporosity and shrinkage.

Conclusions

It is concluded, finally, that sufficient is now understood about the mechanism of refining hyper-eutectic aluminium-silicon alloys and the factors likely to influence the effectiveness of nucleation to make feasible the manufacture of die-cast and certain sand-cast components in this material under production conditions. Thus, the designer, in the automobile and other fields, has available for his consideration a new lightweight, high hardness and wear-resistant aluminium alloy with a coefficient of thermal expansion approaching that of cast iron and steel.

Acknowledgments

The authors wish to thank the directors of High Duty Alloys Ltd. for permission to publish this article.

Properties of Light Alloys

SUMMARIZING elevated temperature, tensile and creep rupture properties of current commercially established aluminium and magnesium alloys which would normally be used at elevated temperatures, a book, "Elevated Temperature Properties of Aluminum and Magnesium Alloys"—STP.291, has been published by the American Society for Testing Materials. Both wrought and cast alloys are covered in various forms such as rolled, forged, or extruded rod, plate, sheet, sand and permanent mould castings; some data are given for Alclad alloys.

Title sheets for each alloy give the alloy designation, chemical composition, and the pertinent specifications under which various forms of the material are supplied. The data sheets for each alloy give a description of the material and the strength values for the mechanical properties. On the graphs, a consistent set of code symbols has been used, where practical, to distinguish types of products, test temperatures and other variables.

Copies of this book may be obtained from A.S.T.M. Headquarters, 1916 Race Street, Philadelphia 3, Pa., at $7.

Obituary

Mr J. Sjögren

WE regret to record the death of Mr. Justus Sjögren, chairman of Sandvik Swedish Steels Limited and Sandvik Steel Band Conveyors Ltd. Mr. Sjögren came to this country in 1901, and was chairman and managing director of Sandvik Swedish Steels Limited from 1914 until 1947, when he left the latter post but continued as chairman, and was chairman of Sandvik Steel Band Conveyors Ltd. from 1921.

Sir A. J. G. Smout

IT is with deep regret that we also record the death of Sir Arthur J. G. Smout. Sir Arthur joined the Elliott group of metal companies in 1905, and became works manager of Elliotts Metal Co. in 1920, later becoming production director of the group. After it merged with Imperial Chemical Industries in 1927, he continued in charge of production and in 1934 became managing director and later chairman of what is now I.C.I. Metals Division. During the war he was appointed a director of I.C.I. and was director-general of small arms ammunition production at the Ministry of Supply from 1942-45. Sir Arthur received his knighthood in 1946, and relinquished his seat on the board of I.C.I. in 1953, becoming chairman of Murex Ltd. He had been a director of Pyrotenax Ltd. since 1937.

Among the many offices he had held were the presidency of Birmingham Metallurgical Society, the presidency of the Institute of Metals, and vice-presidency of the Institution of Mining and Metallurgy. He was also a Fellow of the Royal Institute of Chemistry and a Fellow of the Institution of Metallurgists.

Mrs. J. Wilson

WE also regret to record the death of Mrs. Jane Wilson, a director of Wilson and Jubb (Leeds), Ltd., lead smelters, refiners, lead pipe and printing metal manufacturers. She was a founder member of the company, with which she had been associated for over 30 years.

Industrial News *Home and Overseas*

An Installation

Recent news from **Elm Engineering Limited** is that the company has now installed a Stevens and Bullivant tapering machine. This means that, in addition to supplying aluminium "ElmTube", high-frequency welded, in cut lengths and mechanically polished, the firm can also offer a tapered "ElmTube".

The company is also prepared to taper other people's tube on a tapering service basis, if such service is required.

Volta River Project

Addressing Ghana's National Assembly last Week, President Nkrumah said that he hoped that the contract for the Volta River scheme would be awarded next month. He said he hoped also that work could start by the end of this year and that the first power from the hydro-electric power project could start flowing in September 1965.

President Nkrumah also said a master agreement had been drawn up between the Ghana Government and an aluminium consortium headed by the American Kaiser Aluminum and Chemical Corporation to build a £100,000,000 aluminium smelter near the site of the dam on the Volta River to utilize about half of the power station's potential continuous output of more than 700,000 kilowatts. Once Parliament had approved this master agreement and the financing of the dam and power station was completed, the Government would go ahead and sign the contract with the aluminium consortium, President Nkrumah said.

A Valuable Book

A third edition of "Noble Metal Thermocouples", by H. E. Bennett, F.I.M., has been published by **Johnson, Matthey and Company Ltd.** The book describes the development of the noble metal thermocouple, its applications in steelworks, foundries, and glassworks, and methods of calibration. Curves of temperature against e.m.f. are given for many types of couple incorporating alloys of the platinum group metals, and a chapter describes the chief causes of deterioration in service.

A new feature of the present edition is a short section summarizing the behaviour of the many thermocouple combinations that have been proposed from time to time, and recommending those most suitable for particular applications. Throughout process industry the accurate measurement of high temperatures is of great importance, and the closer control made possible by noble metal thermocouples has contributed to numerous developments. The noble metal thermocouple is simple in construction, robust in use, and consistent in results. In both industry and research it is without equal as a precise means of determining high temperatures.

New Aluminium Rolling Mill

A site near Oswego, New York, has been selected as the location of the $30,000,000 aluminium hot rolling mill to be built and owned jointly by Aluminum Limited, the Bridgeport Brass Company, the Cerro Corporation and the Scovill Manufacturing Company. The project was originally announced in October, 1960.

The plant will have an estimated capacity of 100,000 tons a year. It will produce aluminium reroll stock which will be purchased by the four owners. Reroll stock is a half-processed product. It is a heavy gauge sheet that can be processed to lighter gauges at the sheet mills of the four companies.

New Rolling Mill Plant

A rod mill engineered and built by **Schloemann Aktiengesellschaft** of Düsseldorf, together with the related billet mill has now been put into operation by the Kobe Steel Works Ltd., at Kobe, Japan.

The billet mill comprises four and the rod mill 35 stands. Four-strand rolling is done in the roughing train, two-strand in the intermediate and finishing trains, and the two six-stand finishing trains are each powered by one motor. Rod from 0·197 in. to 1¼ in. gauge is produced.

Sales Office in Canada

It has been announced by the directors of **Hadfields Limited** that H.M.K. Sales Limited (formerly Millspaugh (Canada) Limited) will control and promote the marketing in Canada of all the products of the Hadfields group of industrial companies.

The sales staffs in Canada of the individual companies in the group will continue to serve their customers within the framework of H.M.K. Sales Limited. The head office of the company will be located at 3285 Cavendish Boulevard, Montreal, and regional offices will be maintained in Montreal, Toronto, Owen Sound and Vancouver.

Change of Name

It has been announced by The Mond Nickel Company Limited that its name has been changed to **The International Nickel Company (Mond) Limited.** In announcing this change of name the chairman, Mr. Ivor A. Bailey, said that it did not involve any change in the company's organization or in its business activities. The board, in consultation with The International Nickel Company of Canada Limited, the parent company, took the view that the change of name would, in addition to indicating the international nature of the company's activities, serve to identify it more closely with the Canadian company and the United States affiliate, the International Nickel Company Inc.

Tin Research

Activities of the **Tin Research Institute** are covered by the Annual Report for 1960, which not only includes the work of its premises at Perivale, but also of its offices in the U.S.A., Canada, and six European countries.

The report deals, item by item, with the progress of the researches in the various departments of the Institute. Among the new lines of work mentioned are: tin as a deliberate addition to steel and also in cast iron; aluminium-tin bearings; studies on tin-titanium-oxygen and on tin-titanium alloys; the structure of electrodeposited alloys; bright electro-tin deposits; the reactivity of surface zones in steel strip used for tinplate; the influence of tin on the hardness of silver; and discoveries in the field of organotin chemistry.

Technical conferences on various applications of tin in industry were held in Paris, Brussels, and Brunswick, Germany, during the year. Some thousands of industrial users of tin received technical advice and help during the year, and the Report mentions the main types of enquiries in five categories listed as: tinplate, tin alloys, solders, electrodeposition and compounds of tin. In furtherance of this help to consumers of tin in all countries, many thousands of technical publications were sent to enquirers. A publication that was much in demand was the new free laboratory manual on "Tinplate Testing".

Export Trade

Interesting news from the **Bronx Engineering Company Ltd.** is that it has recently received orders from Czechoslovakia for machinery to a total value of approximately £60,000.

The orders cover a press brake, a mill for making hoes, spades and shovels, a process levelling machine for processing sheet steel before deep drawing, and a large tube straightening machine. The orders were placed by the Czechoslovak Government Buying Agency following several visits to Prague. The company is exhibiting at the Brno Fair in September this year.

Synthetic Enamel

A new one-hour synthetic enamel has been produced by **Teal and Holmes Limited.** Marketed under the trade name "Impervious", this new paint is supplied in both brushing and spraying qualities in a wide range of colours, and gives good coverage. Dust dry in approximately 15 minutes and hard dry in an hour, this enamel is stated to provide an economical, full gloss, tough and flexible film with excellent adhesion, particularly to aluminium sheet without previous priming.

It is also said to be particularly suitable for application on metal, and has already been exhaustively tested on caravan exteriors and can be successfully used for agricultural machinery, vehicle bodies, industrial trucks, and all manner of machinery and metal construction.

Aluminium House Siding

Emerging from under wraps after 15 years of field testing, a new vinyl coating for aluminium house siding was exhibited at the recently-held Paint Industries Show in Chicago by **Union Carbide Corporation.**

Actually under limited distribution for the last two years, this new coated siding is now available following a most rigorous test programme. The siding is produced in white, pastel tints, and in natural wood grain finishes. Costs in different geographical locations vary to a degree and, being not only maintenance free (a mere wash down keeps it looking like new), but also protective against rotting and splitting, this new siding is undoubtedly an attractive economical proposition.

Grid-Controlled Rectifier

Designed for ignition control in welding equipment, motor control duty, or as

a straight grid-controlled rectifier, the Ediswan B12 is a Xenon-filled valve now available from Industrial Valves and Cathode Ray Tubes Department of **A.E.I. Radio and Electronic Components Division.**

This unit, it is stated, is a direct replacement for the American C3JA, and conforms to JAN (Joint Army and Navy) specification. The disc-sealed construction of the valve offers a number of advantages, it is said—it is mechanically robust, the electrical characteristics are maintained to closer limits, the risk of backfiring is reduced, and valve life is increased. Direct heating of the valve, coupled with the use of Xenon gas for filling, reduces the heating time to approximately 30 seconds.

French Aluminium Production

France's aluminium production in 1960 totalled 253,200 tons, compared with 173,000 tons in 1959, Pechiney, France's main producer, announced this week. In addition, the French share in the Cameroun aluminium production by a joint company, Alucam, totalled last year 39,060 tons out of a total output of 43,940 tons. The balance belonged to Belgian interests. Pechiney said that its own Metropolitan output rose from 144,530 in 1959 to 187,300 tons in 1960.

Dechema Monographs

Volume 38 of the Dechema Monographs has just been published and the work includes, among others, 16 Papers which were presented at the Dechema annual meeting in 1959. They deal with new and important advances which have been achieved in various branches of chemical engineering.

Five further Papers concern themes which were discussed at Dechema Colloquia — molecular amplifiers, galvanic fuel elements, the flotation of salts. This volume is of particular value in that it demonstrates the importance of chemical technology in research and education. Abstracts of the individual Papers in English and French are appended so as to make this volume more accessible to European technical circles. A subject index concludes the volume.

Trade with Germany

In accordance with paragraph 87 of the Implementing Ordinance to the German Customs Law, "Binding Customs Rulings" are annulled whenever the basic rates of duty or other customs regulations are altered.

Since a new Customs Tariff has been in operation in West Germany as from January 1 last, incorporating changes in rates of duty, all "Binding Customs Rulings" issued prior to that date have been cancelled. If a binding customs ruling is required, United Kingdom exporters or their German importers or agents should apply for a new binding ruling to the appropriate Customs authority (i.e. the Customs Office through which the goods concerned will be cleared).

Enquiries relating to this notice should be made to Commercial Relations and Exports Department, Board of Trade, Room 4158, Horse Guards Avenue, London, S.W.1, reference C.R.E. 1645/G.

A Birmingham Meeting

Sponsored by the Birmingham Productivity Association and the Chartered Institute of Secretaries, a joint evening meeting will be held on Wednesday next, March 8, at the College of Advanced Technology, Gosta Green, Birmingham, at which Mr. Phillip Bean, A.C.W.A., will give a lecture on "Administration and Productivity". The meeting will commence at 6.30 p.m.

Spanish Lead and Zinc

Recent news from Madrid states that Spanish production of lead in January this year totalled 5,179 metric tons, compared to 2,456 tons in January 1960, according to statistics of the Metal Syndicate. Production of zinc in January this year was 2,925 metric tons, compared to 2,179 tons in January 1960.

Sole Agents

News from **Corrosion Technical Services Ltd.** is that they have been appointed sole United Kingdom agents for Dr. Otto Saurebau und Keramikwerke of Bendorf/Rhein.

The Dr. Otto company is stated to be one of the leading German specialists in the design and erection of pickling plants, both continuous and batch processes, for the steel industry, and in the complementary acid recovery and effluent treatment plants.

A Scottish Office

It is learned from **Ambuco Limited** that they have opened an office at 158 Bath Street, Glasgow, C.2, and that they have appointed Dron and Dickson Limited to act as their representatives in Scotland.

Works and Plant Engineers

A new series of courses which will focus attention on the latest developments in the firing and handling of solid fuel in industrial plants and commercial premises has been announced by the **National Industrial Fuel Efficiency Service.** The courses will be held in Manchester, and the first will commence on Monday, April 10, and finish on Friday, April 14 next. The fee for the course, including hotel accommodation, is 12 gns.

Heat-Treatment Furnaces

To increase output and thus offer quicker deliveries, **Earle, Bourne and Company Ltd.** have recently installed four new heat-treatment furnaces. Designed and built by **G.W.B. Furnaces Ltd.,** these electric batch furnaces will be used for the annealing of brass strip. The complete installation comprises not only the furnaces but also a heavy duty steelworks-type turntable charging machine of Gibbons-van-Marle design and five loading tables.

The heating chambers of these furnaces are 20 ft. long by 5 ft. wide by 3 ft. 6 in. high to crown of door opening. Each furnace is rated at 342 kW in three zones, and is designed for operating up to a maximum temperature of 750°C. Two of the furnaces are equipped with reduced rating input control so that they may operate, with very close temperature uniformity, at lower temperatures for charges requiring stress relieving.

Metals Exhibition

An exhibition is to be presented at the Engineers' Club, Manchester, on March 18, 20 and 22. It is under the auspices of the **International Nickel Company (Mond) Ltd.,** and is designed to interest all concerned with engineering problems involving the use of metals.

The main emphasis of the exhibition will be upon the properties of nickel-containing materials and the platinum metals. For convenience, the exhibits will be divided into seven sections relating to:—the properties of metals at high, normal and sub-zero temperatures; metals versus corrosion; metals for surface protection; metals with special magnetic, expansion or chemical properties; methods of fabrication. Another large section will feature nickel and chromium plating to the new British Standard. During each day lectures will be given by members of the company's development and research department.

Bronze and Brass Founders

A meeting of members in the London area of the **Association of Bronze and Brass Founders** is to be held at the Clarendon Restaurant, Hammersmith, London, W.6, on Wednesday of next week (March 8), following luncheon at 12.30 p.m. for 1 p.m.

New Sales Centre

For the benefit of industry in the West country, the directors of the **Griffin and George Group** announced that their new sales centre in Bristol is now open. The centre is situated at Clothier Road, Brislington Trading Estate, Bristol 4, and is under the management of Mr. W. J. Smith.

Metal Finishing

Advance notice is given of the annual conference of the **Institute of Metal Finishing,** which this year is to be held at Llandudno from May 2 to 6. The Hothersall Memorial Lecture will be given on May 4 by Dr. Abner Brenner, who is chief of the electrodeposition section of the U.S. National Bureau of Standards.

Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell by 8 tons to 10,145 tons, comprising London 4,282, Liverpool 3,823, and Hull 2,040 tons.

Copper stocks rose 325 tons to 15,075, and were distributed as follows: London 925, Liverpool 12,000, Birmingham 100, Manchester 2,000, and Hull 50 tons.

Lead duty-free stocks fell 125 tons to 7,163 tons, while in-bond stocks were unchanged at 3,867 tons. All supplies were in London.

Zinc duty-free stocks rose 201 tons to 3,277 tons, while in-bond stocks fell 150 tons to 350 tons, comprising London duty-free 908 tons and in-bond 350 tons, Liverpool duty-free 2,339 tons and in-bond nil, and Glasgow duty-free 30 tons and in-bond nil.

Aluminium in Venezuela

It is reported from Caracas that the new aluminium plant jointly financed by the Venezuelan Government and the Reynolds Aluminium Company will begin operating within two years near Puerto Ordaz on the River Orinoco.

The plant, which will take nine months to construct at a cost of 33 million dollars, will play an important part in the plans which the Government has for the development of the Venezuelan Guayana, the south-eastern part of the country below the River Orinoco, which not only contains rich manganese and bauxite deposits, but also iron ore reserves estimated at 4,000 million metric

tons and equal in value to the country's entire reserves of petroleum. This high grade ore will be reduced in a State-owned steel mill in Guayana, and the two plants, when in operation, are expected to attract a large number of satellite industries.

Italian Copper Statistics

Italian imports of crude copper for refining in the first 11 months of 1960 were 13,336·8 metric tons, valued 5,672,995,000 lire, of which 60·9 metric tons, valued at 25,016,000 lire were imported temporarily, according to figures released by the Central Statistical Institute. The principal suppliers were the Federation of Rhodesia and Nyasaland with 6,590·9 metric tons, South Africa with 2,935·9, Chile 1,712·2, and the U.S. 1,589·9 metric tons.

Imports of refined copper in slabs, ingots, plates, etc., totalled 159,400·9 metric tons, valued at 65,133,527,000 lire, of which 19,210·6 metric tons, valued at 8,239,747,000 lire were imported temporarily. The principal sources of supply were : Belgium / Luxembourg 4,718·6 metric tons; France 5,556·8; United Kingdom 9,655·5; ex-Belgian Congo 29,877·4; Rhodesia and Nyasaland 25,759·5; South Africa 9,210·5; Chile 25,292·6; and the United States 41,391·2 metric tons.

Malayan Tin Mining Statistics

Malaya produced in January 101,444 piculs of tin-concentrates, containing 4,565 tons of metal based on an assay value of 75·60 per cent, according to Malayan mining statistics. This compared with the December figures of 103,222 piculs, 4,646 tons and 75·62 per cent respectively. The average daily rate of production in January was 3,272 piculs (3,330 previously) of tin-concentrates.

Deliveries of tin-concentrates from mines to smelters were 99,340 piculs (110,312 previously), containing 4,470 tons of tin metal based on an assay of 75·60 per cent. At the end of the month, there were 70 dredges, 480 gravel-pump mines and 53 other mines in operation, making a total of 603 active tin mines, compared with a total of 591 in the previous month.

Melting Metals

A new unit has been introduced by **R. J. Hooker Limited** in the form of the O.P. Hookercaster, which is designed to melt all metals from light alloys to gold and silver, through the range of non-ferrous metals, up to steel and platinum, which has a melting point of 1,750° C.

The manufacturers state that the combination of melting unit with the centrifugal casting unit ensures that the cast is made within seconds of the metal reaching the right temperature and without the need to remove the crucible. The casting is thus made, under optimum conditions, not only quickly but cleanly and economically, reproducing fine details with precision and giving excellent physical properties.

It is explained that this piece of equipment is designed to be used in conjunction with the "Investril" process, or it can be operated quite independently if required. With each machine there is supplied a small quantity of "Investril" products to enable the machine to operate in accordance with the system immediately upon delivery.

New Electrode Holder

Specially designed and developed to combat heat generated during heavy welding operations at high duty cycles, the Courtburn "air insulated" 600 amp. electrode holder is claimed by the manufacturers—**Courtburn Supplies Ltd.**—to be one of the most advanced of its type available, whilst remaining light and easy to handle.

Its secret is said to lie in the construction of the body. Two circular distance pieces made from heat-resistant material separate the cable, cable connection and plunger from the handle. Consequently, the heat generated by current passing through the cable is dissipated by an insulating barrier of air; operators can, therefore, maintain continuous welding without suffering discomfort.

Copper Cartel Request

It has been reported from Washington, U.S.A., that the White House has rejected a request from Senator Mansfield, Democrat, Montana, that President Kennedy lend his influence to the possible establishment of an International Cartel to stabilize copper prices. Declaring that over-production has depressed prices and caused unemployment, the Montana Senator suggested to the President that a voluntary agreement by producers throughout the world to limit production would bring prices up.

In his reply, Presidential Assistant Lawrence O'Brien, by implication, rejected the Senator's proposal. Referring to a 1958 international copper meeting held in London under the auspices of the United Nations, Mr. O'Brien asserted: "It is claimed conditions relative to copper then probably were less favourable than now, but the conference concluded that Governmental actions at the international level were not necessary". However, Mr. O'Brien informed Senator Mansfield that the President is asking the State Interior and Commerce Departments to "re-examine and keep under review the copper situation" and submit their views directly to the Senator.

Senator Mansfield's reply to Mr. O'Brien implied that he felt the White House was missing the point. "It was not my intention that action at the Governmental level be undertaken, but it was my hope that it would be possible for our Government to issue a call for such a meeting to the end that there could be held a conference of the copper producers throughout the world", the Senator said.

Aluminium Anniversary

To link up with the 75th anniversary of Charles Hall's discovery of a commercially practical method for electrolytic aluminium reduction, the January-February issue of *Kaiser Aluminium News* contains an historical review of the development of the aluminium industry and aluminium metallurgy.

Many illustrations are included in the 30 pages covering this review, which goes back to 5,300 B.C. and traces many interesting developments in metals right up to the present day, and the review concludes with a chronology of metals in colour, including the metals of antiquity and the founding of the aluminium industry.

Advance Tin Statistics

Provisional figures of mine production of tin-in-concentrates in the Congo have been received for October (641 tons), November (712 tons) and December (556 tons). The combined output of the Congo and Ruanda-Urundi in 1960 is provisionally put at 10,085 tons, compared with 10,314 tons in 1959. Production in the Federation of Malaya in December was 4,646 tons, giving a total for 1960 of 51,979 tons, as against 37,525 tons in 1959. Comparable figures for Nigeria and Thailand are as follows: Nigeria: December, 1960, 684 tons; January-December, 1960, 7,675 tons; January-December, 1959, 5,523 tons; Thailand: December, 1960, 988 tons; January-December, 1960, 12,080 tons; January-December, 1959, 9,684 tons.

Smelter production of tin metal in Belgium in December amounted to 853 tons, production in 1960 as a whole was 7,947 tons (1959, 6,638 tons). Output in the United Kingdom declined slightly in January to 2,292 tons (December, 2,396 tons).

Forthcoming Meetings

March 6 — Institute of Metal Finishing. North-West Branch. Engineers' Club, Albert Square, Manchester. "Chromate Treatment of Metals." 7.30 p.m.

March 6—Institution of Plant Engineers. Sheffield and District Branch, Station Hotel, Chesterfield. "Industrial Diseases and Factory Hygiene." Dr. Hartley. 7.30 p.m.

March 7.—Institute of Metals. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. "Novel Methods of Forming Metals." 7.15 p.m.

March 7—Institute of Metals. South Wales Local Section. Metallurgy Department, University College, Singleton Park, Swansea. "Fracture of Metals." 6.30 p.m.

March 7—Institute of Metal Finishing. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. "The Testing of Electrodeposits for Thickness and Corrosion Resistance." J. Edwards. 6.30 p.m.

March 8—Institute of Metal Finishing. Organic Finishing Group. British Institute of Management, 80 Fetter Lane, London, E.C.4. "Automatic Paint Finishing of Refrigerators." B. Jeffrey. 6.30 p.m

March 8—Society of Chemical Industry. Joint meeting of Corrosion Group and Newcastle Section. Northgate Hall of the College of Further Education, Gladstone Street, Darlington. "Metal Spraying for the Protection of Bridge Structures." J. D. Thompson. 8 p.m.

March 9 — East Midlands Metallurgical Society. Faculty of Applied Science, Clifton Boulevard, The University, Nottingham. "Metallurgy of the Steam Turbine." Dr. L. E. Benson. 7.30 p.m.

March 9—Institute of Metals. London Local Section. The Horse Shoe Hotel, Tottenham Court Road, London, W.1. Annual Informal Dinner.

March 9—Liverpool Metallurgical Society. Department of Metallurgy, University of Liverpool. "Creep Deformation." Dr. D. M. McLean. 7 p.m.

March 9 — Society of Instrument Technology. Liverpool Section. M.A.N.W.E.B. Industrial Development Centre, Liverpool. "Design Application and Selection of Automatic Control Valves." P. Stone. 7 p.m.

March 10—Institute of Metal Finishing. London Branch. Constitutional Club, Northumberland Avenue, London, W.C.2. Practical Platers' Night. 6 p.m.

Metal Market News

A CHEERFUL tone obtained on the Metal Exchange last week and, with the exception of lead, which, however, closed above the lowest, gains were registered, copper and tin being particularly firm. It begins to be apparent that industrial activity in the United States has taken a turn for the better but, so far, the improvement is comparatively slight. Unemployment is still very high, and it may be that it has not yet reached its peak.

Here in the United Kingdom, it also appears that the minor depression which showed itself after Christmas has, to some extent, receded, and in the motor car industry at any rate a longer week is being worked. If the Stock Exchange is any guide, then the outlook is reasonably good for the second quarter of the year. In the realm of non-ferrous metals supplies are adequate and, indeed, in lead it would seem that there is too much metal coming along. An exception is to be found in scrap, where practically all types are scarce and, for the most part, standing at relatively high prices. In the background, of course, are the events in Rhodesia and the Congo. Last week saw a further deterioration at both these centres, and the price of standard copper was obviously affected by adverse reports of developments which could well lead to interference with supplies. It does not appear, so far, that there has been any interference with output at Katanga, and it must be presumed that all the metal is being shipped.

Dealing in the copper ring was active throughout the week, and the turnover reached 15,000 tons, without Kerb tonnage, which must have been higher than usual. Steady progress in the value of the metal was made from Monday to Friday, and the close at £230 10s. 0d. was the high point of the week.

Most regrettably, a backwardation has made its appearance, and the closing quotation for three months copper was 10s. lower than cash. On balance, therefore, there was a gain of £6 10s. 0d. in cash, and of £5 10s. 0d. in three months, the tone of the market being quite firm. A spate of bear covering must be blamed for the premium in the prompt position, and one would hardly expect a backwardation to continue, for stocks are still fairly ample. At the beginning of last week it was announced that a fall of 225 tons in warehouse tonnage brought the total down to 14,750.

Apart from events in Africa, news of a Chilean dock strike imparted a firm tone to the copper market. Moreover, some evidence that curtailment is having its effect was afforded by a report that Chile's output in January, at 42,244 tons, was nearly 6,000 tons lower than December. Stocks of tin in Metal Exchange warehouses went up by 55 tons to 10,153 tons, but the tone of the market was decidedly firm, and cash closed £10 dearer at £804 10s. 0d. Three months gained £9 at £806. The turnover was 1,165 tons. Under heavy selling pressure, cash lead fell back to £64 5s. 0d. before recovering, to close at £65 10s. 0d., a net loss on the week of 30s. Three months was 5s. cheaper, and showed a loss of 27s. 6d. The turnover was 8,350 tons. Zinc closed 12s. 6d. above the lowest at £84 17s. 6d. for cash and 17s. 6d. up on the week. Three months, at £83 15s. 0d., showed a gain of 7s. 6d. Some 9,300 tons changed hands.

Birmingham

The improvement in the motor trade is now reflected in a drop in the unemployed in the Midlands. Over the last month, the figures have fallen from 45,170 to 40,153. The unemployment rate has fallen from 2 per cent to 1·8 per cent, only a shade over the national average of 1·7 per cent. Unfilled vacancies stand at 32,461, compared with 33,319 a month ago, even after labour exchanges had placed 11,660 persons in new jobs. The position has changed chiefly because of the reduction in the number of short-time workers. Other metal-using industries are steadily employed. Machine tool order books are lengthening, and manufacturers are said to have more than ten months' work in hand.

Stocks of iron and steel are higher than they were a year ago, and suppliers are well able to meet any increasing demand which may arise from revival in the motor trade. The structural steel market is still very active with a substantial tonnage of material being delivered weekly to building sites in Midland towns and cities, where a great deal of reconstruction is in progress. The re-rolling mills are busy on small sections and bars. There is room for improvement in the foundries making light castings. Makers of heavy electrical equipment have received further substantial contracts recently.

New York

Copper futures were firm and active at the week-end, aided by the advance in London and the tense Central African situation, as well as the spreading Chilean port strike. There was covering and new buying in the market. In physical copper, traders noted that custom smelters and producers were capturing the consumer business at 29 cents, dealers mostly being bypassed. One leading custom smelter reported quite active copper sales for nearbys. Producers indicated fair sales. Scrap copper prices were unchanged. Offerings were tight. Tin was barely steady and quiet. Lead and zinc were active at an average price basis.

The General Services Administration has announced that it will sell about 1,700 short tons of nickel ore and speiss declared surplus to the national stockpile. G.S.A. invited bids on 1,400 short tons of nickel cobalt speiss and 314 short tons of arsenical nickel ore now located at the Government's facility in Ravenna, Ohio.

Paris

Business was erratic on the non-ferrous scrap market last week, although some types, particularly copper and alloys, were firm. Bright electrolytic copper was marked up by sellers because of the rise in London. Buyers, however, were reluctant to follow, arguing that the present margin with primary copper was too small. Active and firm conditions ruled for bronze, and there was selective buying of brass grades. The aluminium market was nominal, with traders unwilling to deal at the present price levels. Lead and zinc were unchanged, with a small routine turnover noted.

Chile

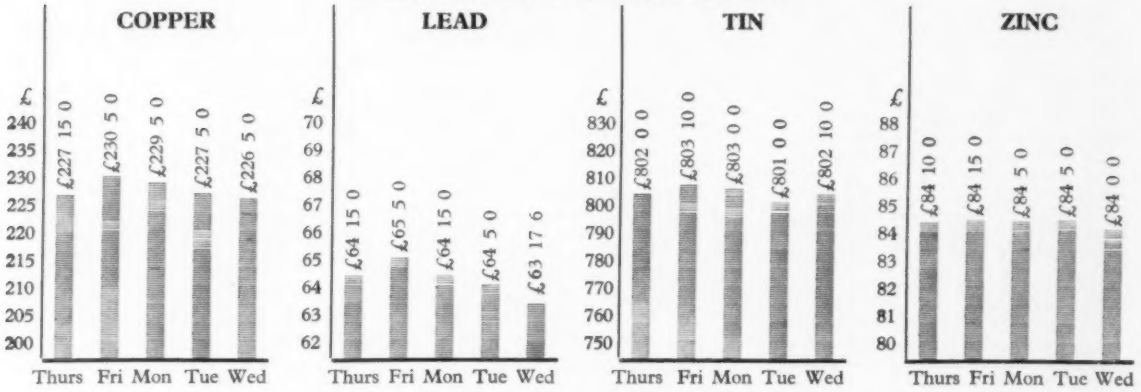
There is a great possibility of finding important copper ore deposits in the northern province of Tarapaca, according to a report released in Santiago by the Institute of Geological Research. The report said detailed studies had been made of copper ore deposits in El Salar and Santo Domingo, near Arica, and those of Poricos, Cerro Colorado and Mocha, in Iquique. It added that, as a result of these first investigations, "favourable geological circumstances have been established in the province of Tarapaca, which might indicate the existence of disseminated copper deposits which, eventually, may materialize in the development of deposits of great importance".

It is also reported that an electrolytic copper refinery, to complement the copper smelter of Las Ventanas, will be built by the National Mining Enterprise (Empresa Nacional de Mineria), a part-state agency. This refinery, as well as the smelter, will serve the needs of the so-called small and medium copper mining industries. The plan presents currently two alternate aims—the construction of a refinery with a capacity production of 72,000 tons annually of electrolytic copper, or one with a capacity of 120,000 tons. A decision on this will be taken as soon as new studies comparing construction investments have been completed.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 23 February to Wednesday 1 March 1961



Primary Metals

All prices quoted are those available at 2 p.m. 1/3/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	217	10	0
Antimony Metal 99%	„	210	0	0
Antimony Oxide Commercial	„	194	10	0
Antimony White Oxide	„	196	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	0
Calcium	„	2	0	0
Cerium 99%	„	15	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite	per unit		8	10
Copper H.C. Electro	ton	228	0	0
Fire Refined 99·70%	„	227	0	0
Fire Refined 99·50%	„	220	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	11	0
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	66	12	6
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, AZ91X	„		1 1½-2	1½
Manganese Metal	ton	280	0	0
Mercury	flask	69	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	122	0	0
Silver Spot Bars	oz.		6	7⅛
Tellurium Sticks	lb.	2	0	0
Tin	ton	802	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	83	7	6
Dust 95/97%	„	125	0	0
Dust 98/99%	„	131	0	0
Granulated 99+%	„	108	7	6
Granulated 99·99+%	„	123	17	6

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton	**Canada** c/lb≏£/ton	**France** fr/kg≏£/ton	**Italy** lire/kg≏£/ton	**Switzerland** fr/kg≏£/ton	**United States** c/lb≏£/ton
Aluminium		26.00 210 12	2.43 179 11	370 216 1	2.50 210 5	26.00 207 4
Antimony 99.0			2.30 170 0	495 289 1		29.00 231 2
Cadmium			15.75 1,069 0			150.00 1,195 10
Copper						
Crude				435 254 0		
Wire bars 99.9						
Electrolytic	31.00 226 10	27.50 222 15	3.17 234 5		2.83 238 0	29.00 231 6
Lead		10.60 85 17	.94 69 9	165 97 7	.83 69 16	11.00 87 13
Magnesium						
Nickel		70.00 567 0	9.00 665 2	1,200 699 6	7.50 630 15	74.00 589 15
Tin	111.50 814 19		11.34 848 0	1,500 876 0	9.58 805 12	102.25 814 10
Zinc						
Prime western		12.00 97 4 0				
High grade 99.95		12.60 102 1 0				
High grade 99.99		13.00 105 6 0			1.10 92 10	
Thermic			1.20 88 13			
Electrolytic			1.28 94 13	189 110 7		13.00 104 0

C

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 1/3/61

	£	s.	d.
Aluminium Alloy (Virgin)			
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10.... „	221	0	0
B.S. 1490 L.M.11.... „	215	0	0
B.S. 1490 L.M.12.... „	223	0	0
B.S. 1490 L.M.13.... „	216	0	0
B.S. 1490 L.M.14.... „	224	0	0
B.S. 1490 L.M.15.... „	210	0	0
B.S. 1490 L.M.16.... „	206	0	0
B.S. 1490 L.M.18.... „	203	0	0
B.S. 1490 L.M.22.... „	210	0	0
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	171	0	0
B.S. 1490 L.M.2 .... „	174	0	0
B.S. 1490 L.M.4 .... „	183	0	0
B.S. 1490 L.M.6 .... „	183	0	0
***Aluminium Bronze**			
BSS 1400 AB.1..... ton	245	0	0
BSS 1400 AB.2..... „	254	0	0

	£	s.	d.
***Brass**			
BSS 1400-B3 65/35 .. ton	177	0	0
BSS 249 ..... „		—	
BSS 1400-B6 85/15 .. „	226	0	0
***Gunmetal**			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	221	0	0
(86/7/5/2) LG3 ..... „	230	0	0
(88/10/2/1) ..... „	284	0	0
(88/10/2/½) ..... „	294	0	0
***Manganese Bronze**			
BSS 1400 HTB1..... „	197	0	0
BSS 1400 HTB2..... „	213	0	0
BSS 1400 HTB3..... „	232	0	0
Nickel Silver			
Casting Quality 12% „	235	0	0
„ „ 16% „	250	0	0
„ „ 18% „	290	0	0
***Phosphor Bronze**			
B.S.1400P.B.1.(A.I.D. released) ..... „	311	0	0
B.S. 1400 L.P.B.1 „	243	0	0

**Average prices for the last week-end.*

	£	s.	d.
Phosphor Copper			
10% ..... ton	258	0	0
15% ..... „	261	10	0
Phosphor Tin			
5% ..... „	871	0	0
Silicon Bronze			
BSS 1400-SB1 ..... „	285	0	0
Solder, soft, BSS 219			
Grade C Tinmans ... „	367	15	0
Grade D Plumbers .. „	294	5	0
Grade M ..... „	404	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
BSS 1004 Alloy A .. ton	117	7	6
BSS 1004 Alloy B.... „	121	7	6
Sodium-Zinc ..... lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			
Sheet 10 S.W.G. lb.	2	10½	
Sheet 18 S.W.G. „	3	0½	
Sheet 24 S.W.G. „	3	3½	
Strip 10 S.W.G. „	2	10½	
Strip 18 S.W.G. „	2	11½	
Strip 24 S.W.G. „	3	1	
Circles 22 S.W.G. „	3	4½	
Circles 18 S.W.G. „	3	3½	
Circles 12 S.W.G. „	3	2½	
Plate as rolled ..... „	2	10	
Sections ..... „	3	4	
Wire 10 S.W.G. .... „	3	1½	
Tubes 1 in o.d. 16 S.W.G. ..... „	4	4	
Aluminium Alloys			
BS1470. HS19W.			
Sheet 10 S.W.G. „	3	3	
Sheet 18 S.W.G. „	3	5½	
Sheet 24 S.W.G. „	4	1	
Strip 10 S.W.G. „	3	3	
Strip 18 S.W.G. „	3	4½	
Strip 24 S.W.G. „	4	0½	
BS1477. HP30M.			
Plate as rolled ..... „	3	1	
BS1470. HC15WP.			
Sheet 10 S.W.G. „	4	3	
Sheet 18 S.W.G. „	4	8½	
Sheet 24 S.W.G. „	5	8½	
Strip 10 S.W.G. „	4	4	
Strip 18 S.W.G. „	4	8½	
Strip 24 S.W.G. „	5	4½	
BS1477. HPC15WP.			
Plate heat treated ... „	3	10½	
BS1475. HG19W.			
Wire 10 S.W.G. „	4	2	
BS1471. HT19WP.			
Tubes 1 in. o.d. 16 S.W.G. ..... „	5	5	
BS1476. HE19WP.			
Sections ..... „	3	4	
Split tube			
19 S.W.G. (⅛") ..... „	4	2	
20 S.W.G. (⅜") ..... „	3	11	
21 S.W.G. (⅜") ..... „	4	1	
22 S.W.G. (¼") ..... „	4	11	
Welded tube			
14 to 20 S.W.G. (sizes ⅛" to 1⅛") .... „	3/10½ to 5/8½		

Brass			
Tubes ..... lb.	1	10	
Brazed Tubes ..... „	3	3	
Drawn Strip Sections „	3	2½	
Sheet ..... ton	200	5	0
Strip ..... „	200	5	0
Extruded Bar ..... lb.	2	0½	
Condenser Plate (Yellow Metal)..... ton	188	0	0
Condenser Plate (Naval Brass)..... „	200	0	0
Wire ..... lb.	2	8½	
Beryllium Copper			
Strip ..... „	1	4	11
Rod ..... „	1	1	6
Wire ..... „	1	4	9
Copper			
Tubes ..... lb.	2	2½	
Sheet ..... ton	262	10	0
Strip ..... „	262	10	0
H.C. Wire ..... „	281	5	0
Cupro Nickel			
Tubes 70/30 ..... lb.	3	6½	

Lead			
Pipes (London) ..... ton	107	0	0
Sheet (London) ..... „	104	15	0
Tellurium Lead ..... „	£6 extra		
Nickel Silver			
Sheet and Strip 10%.. lb.	3	10½	
Wire 10% ..... „	4	3½	
Phosphor Bronze			
Wire ..... „	4	1¼	
Titanium (1,000 lb. lots)			
Billet 4½" to 18" dia..... lb.	47/-	48/-	
Rod ½" to 4" dia..... „	85/-	53/-	
Wire ·036"-232" dia.... „	159/-	99/-	
Strip ·001" to ·048".... „	350/-	68/-	
Sheet 8'×2'. 20 gauge „	73/-		
Tube, representative average gauge ..... „	198/-		
Extrusions ..... „	90/-		
Zinc			
Sheet ..... ton	122	5	0
Strip ..... „	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 28/2/61.

	£
Aluminium	
New Cuttings	141
Old Rolled	114
Segregated Turnings	74
Brass	
Cuttings	162
Rod Ends	145
Heavy Yellow	137
Light	132
Rolled	152
Collected Scrap	136
Turnings	139
Copper	
Wire	210
Firebox, cut up	207
Heavy	205
Light	202
Cuttings	212
Turnings	189
Braziery	182

	£
Gunmetal	
Gear Wheels	200
Admiralty.....	200
Commercial	187
Turnings	182
Lead	
Scrap	57
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	187
Turnings	182
Zinc	
Remelted	75
Cuttings	64
Old Zinc	44

Financial News

George Cohen 600 Group

The directors of this group have declared an interim dividend of 4½ per cent actual, less tax, on the £3,125,000 Old Ordinary Stock of the company, payable on March 31, 1961, in respect of the financial year ending on that date.

The directors have also resolved that the half-yearly dividend due on March 31, 1961, on the £1,500,000 4½ per cent Cumulative Preference Stock of the company be paid at the rate of 4½ per cent per annum, less tax, and that the half-yearly dividend due on March 31, 1961, on the £1,000,000 6½ per cent Second Cumulative Preference Stock of the company be paid at the rate of 6½ per cent per annum, less tax.

Reynolds Metals Company

It is reported from New York that the company has announced that its net sales in 1960 totalled 438,724,000 dollars—the poorest showing since 1954. In 1959 the company's net sales amounted to 489,263,000 dollars. Earnings last year were 1·26 dollars per share, against 2·39 dollars in 1959.

Companies in U.S.A.

It was announced last week-end that directors of Kaiser Aluminum and Chemical Corporation of Oakland (California) and Kawneer Company of Niles (Michigan) have agreed to Kaiser's purchase of Kawneer for about 30,000,000 dollars in an exchange of stock A Kaiser spokesman said the merger was subject to a vote of both companies' stockholders, which "should take place within a couple of months". Under the agreement, Kawneer would become an operating division of Kaiser. The merger agreement called for Kaiser to exchange a half-share of its common and one-tenth share of its 100 dollars par value 4¼ per cent convertible preference stock for each share of Kawneer common, the spokesman said. This was equal to a total of 469,132 shares of common and 93,827 shares of preference stock of Kaiser for the 938,236 shares of Kawneer common outstanding. Kawneer manufactures aluminium architectural products. It has eight manufacturing plants.

Cerro Corporation announced the purchase of United Pacific Aluminium Corporation for 100,000 shares of Cerro common stock — worth 3,625,000 dollars at the close on February 21. The aluminium company's stockholders will get one share of Cerro for each 4·77 shares of United Pacific owned.

Thos. Bolton and Sons Ltd.

Trading profit is shown at £448,067 (£286,690), and the net profit at £195,388 (£92,993). It is proposed to increase the dividend to 12½ per cent by adding a 2½ per cent bonus.

Broken Hill Companies

It is reported from Broken Hill that Mr. A. R. West, President of the Mining Managers' Association, has stated that Broken Hill mining companies planned to maintain production of lead this year at about the same level of output as at present. Rumours had recently circulated in union circles about a cut in production by the mining companies and that certain levels in the Zinc-New Broken Hill Consolidated mines would be closed.

Early last year, Broken Hill mines resumed operations on a 10-day working fortnight after nearly two years of reduced production because of the over-supply of lead on the world market. Meanwhile, the lead bonus payable to all employees of Broken Hill mining companies will drop next month to its lowest level since 1950. It will be cut by 5s. to a rate of £A1 12s. 0d. a shift, or £A8 for each full week worked. The March bonus is calculated on the average realized price of lead in January, which was £A79 0s. 4d. a ton.

Rectifier Prices

Following recent reductions in the prices of its silicon diodes, Westinghouse Brake and Signal Company has now announced reductions, amounting in some cases to 50 per cent, in the prices of Trinistor silicon controlled rectifiers. In addition, a new range of Trinistors with current ratings of 16 amperes and voltage ratings of 25-400 volts has been introduced and supplements the existing 25-ampere range.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£225.7.0) 3.05
Heavy copper	(£225.7.0) 3.05
No. 1 copper wire	(£208.7.0) 2.82
Brass rod ends	(£164.1.0) 2.22
Zinc castings	(£65.0.0) 0.88
Lead	(£64.5.0) 0.87
Aluminium	(£134.9.0) 1.82

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0) 305
Lead, soft, first quality	(£79.10.0) 136
Lead, battery plates	(£43.16.0) 75
Copper, first grade	(£207.6.0) 355
Bronze, commercial gunmetal	(£169.7.0) 290
Brass, heavy	(£140.3.0) 240
Brass, light	(£125.11.0) 215
Brass, bar turnings	(£143.1.0) 245
Old zinc	(£57.4.0) 98

Japan (Yen per metric ton):

Electrolytic copper	(£—)	273,000
Copper wire No. 1	(£—)	253,000
Copper wire No. 2	(£—)	234,000
Heavy copper	(£—)	243,000
Light copper	(£—)	203,000
Brass, new cuttings	(£—)	185,000
Red brass scrap	(£—)	212,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£208.1.0) 240
Heavy copper	(£199.8.0) 230
Light copper	(£173.8.0) 200
Heavy brass	(£125.14.0) 145
Light brass	(£86.14.0) 105
Soft lead scrap	(£50.5.0) 58
Zinc scrap	(£47.13.0) 55
Used aluminium unsorted	(£78.1.0) 90

Trade Publications

Chemicals for Metal Treatment. — The Geigy Company Ltd., Rhodes, Middleton, Manchester.

The development division of this company has issued a most useful brochure in which details of their range of chemicals for use in the treatment of metals are given. Arranged in alphabetical order, the various chemicals are listed showing their chemical nature, availability, appearance and properties, and applications.

Anti-Corrosive Protection. — Croda Ltd., Cowick Hall, Snaith, Goole, Yorks.

A technical data sheet deals with Promax, which is a complementary product to this firm's "Crocell" range of thick film hot dip strippable plastics coatings for anti-corrosive protection. Promax forms a tough, elastic skin on metal surfaces which protects them against corrosion, abrasion, scuffing, etc., under a wide range of conditions. It is said to be sufficiently adherent to the metal surface to "stay put", but can easily be removed by peeling.

Resistance Welding. — Enfield Rolling Mills Limited, Brimsdown, Enfield, Middx.

A new brochure dealing with "ERM" resistance welding electrode materials has just been issued by this company. A special department for the production of high strength high conductivity copper alloys has been set up. Full details of these materials, accompanied by statistical data, diagrams, illustrations, etc., are contained in this 18-page book.

Information Data.—Suffolk Iron Foundry (1920) Ltd., Sifbronze Works, Stowmarket, Suffolk.

Four new leaflets have been issued by this company. Super Silicon No. 9 demonstrates how the welding joint can have the full properties of the parent metal. The leaflet gives details of preparation, technique and after-weld treatment. S.I.F. silver-solder is described as being excellent for low-temperature (silver) brazing, and S.I.F. stainless steel welding wires are specially prepared for the inert-gas-arc or oxy-acetylene welding processes. A leaflet gives details of the various specifications. Another leaflet describes Sifbronze fluxes, which have been developed for all metals and varying types of welding, and assist in the prevention of such common complaints as oxidation and corrosion.

P.V.A. Emulsion Paints. — British Titan Products Company Limited, 10 Stratton Street, London, W.1.

This booklet, covering nearly 60 pages, is intended to give factual information about formulation, manufacture, stability, application properties and exterior durability of polyvinyl acetate emulsion paints to the extent that these features are affected by pigmentation with titanium oxide. It draws attention to a number of simple points which experience has shown to be of vital importance when dealing with these paints, but it is explained that many of the principles set out can be extended to paints based on other types of emulsion. The subject matter is divided into sections which can be read separately, although all are complementary, and each section carries a summary for easy reference. There are also a number of photographs and diagrams.

THE STOCK EXCHANGE

Engineering Shares Continued In Demand

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 27 FEBRUARY	+ RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1960-61 HIGH	1960-61 LOW	1959 HIGH	1959 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	31/–	+2/–	11	9	7 2 0	34/9	25/6	33/3	23/3
400,000	2/–	Anti-Attrition Metal	1/–		NIL	4	NIL	1/6	0/9	1/7½	1/–
41,303,829	Stk. (£1)	Associated Electrical Industries ...	42/3	+1/6	15	15	7 2 0	67/3	39/3	67/–	54/–
3,236,424	1	Birfield	49/9	—1/9	10	15‡	4 0 6	52/–	29/–	75/4½	46/–
4,795,000	1	Birmid Industries	79/6	+3/6	20	20D	5 4 6	79/6	56/–	75/6	46/9
5,630,344	Stk. (10/–)	Birmingham Small Arms	33/–	+2/6	17½QT	12½	3 10 0	33/–	18/4½	69/–	36/–
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6		5	5	6 18 0	17/4½	14/4½	17/6	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/4½		6	6	6 17 3	20/–	16/6	20/1½	17/9
500,000	1	Bolton (Thos.) & Sons	43/9		10	10	4 11 6	43/9	37/-	47/–	27/6
300,000	1	Ditto Pref. 5%	14/–		5	5	7 2 9	16/–	13/6	16/–	14/9
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/–		6	6	7 1 3	21/1½	16/9	21/6	18/9
18,846,647	Stk. (£1)	British Insulated Callender's Cables	55/9		13½	13½	4 16 9	61/–	47/6	61/–	45/1½
17,047,166	5/–	British Oxygen Co. Ltd., Ord. ...	30/6	—3d.	16	16	2 12 6	34/6	19/6	87/9	49/3
1,200,000	Stk. (5/–)	Canning (W.) & Co.	17/–	+9d.	15+8½C	25+ *2½C‡	4 8 3	19/6	13/3	18/1½	12/3
60,484	1/–	Carr (Chas.)	1/4½	+1½d.	NIL	12½	—	2/3	1/–	2/10½	1/3
555,000	1	Clifford (Chas.) Ltd.	27/–	+9d.	10	10	7 8 3	35/–	26/–	30/–	22/6
46,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	16/–	15/3	16/–	17/–
300,000	2/–	Coley Metals	4/–		15	15	7 10 0	5/–	3/3	4/6	2/6
10,185,696	1	Cons. Zinc Corp.†	68/6	—1/3	20	15	5 16 9	80/–	60/6	77/3	57/9
5,399,056	1	Davy-Ashmore	154/–	+4/–	30‡	20	1 18 9	154/–	100/6	116/–	43/–
7,695,000	5/–	Delta Metal	22/3	+3d.	17½	31‡	3 18 9	28/–	18/7½	26/4½	11/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	45/3	—6d.	15	15	6 12 9	56/3	45/–	61/9	36/7½
1,155,000	1	Evered & Co.	44/–		10B	10♦	3 0 0	42/9	29/–	42/6	30/–
18,000,000	Stk. (£1)	General Electric Co.	31/6xd	+6d.	10	10	6 7 0	51/6	29/3	50/6	30/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	51/6	+1/6	20	20	3 17 9	51/6	40/–	47/–	31/4½
750,000	5/–	Glacier Metal Co. Ltd.	14/9		13	11½	4 9 9	15/9	11/1½	11/3	6/7½
2,500,000	5/–	Glynwed Tubes	23/9		25¶	20	3 13 0	27/1½	17/7½	30/9	16/1½
7,228,065	10/–	Goodlass Wall & Lead Industries ...	39/3	+9d.	19L	16	3 15 0	41/6	33/4½	53/–	28/7½
696,780	10/–	Greenwood & Batley	25/–xcap	—3d.	30W	30	6 0 0	27/–	23/9Z	130/–	75/–
792,000	5/–	Harrison (B'ham) Ord.	12/4½		*20‡	*17½	4 0 9	15/4½	11/9	26/9	14/–
150,000	1	Ditto Cum. Pref. 7%	20/–		7	7	7 0 0	20/–	19/3	19/6	19/4½
1,075,167	5/–	Heenan Group	15/3	+2/3	13D	15	3 14 0P	15/3	10/–	19/6	7/4½
249,932,548	Stk. (£1)	Imperial Chemical Industries ...	69/6	—9d.	11¼N	8	3 4 9	75/3	54/–	62/7½	33/1½
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/9		5	5	6 7 0	17/9	15/3	19/1½	15/6
22,184,044	**	International Nickel	117½	—½	$1.60	$1.50	2 11 3	118½	85½	201½	154½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/3		5	5	7 0 3	16/6	13/9	17/6	14/9
6,000,000	1	Ditto Ord.	61/6	—9d.	12	12D	3 18 0	66/6	45/–	50/3	27/3
600,000	10/–	Keith, Blackman	20/3		17½	17½E	8 12 9	32/6	17/9	32/–	25/–
320,000	4/–	London Aluminium	10/4½		12	10	4 12 6	12/6	7/6	10/7½	5/3
765,012	1	McKechnie Bros. Ord.	55/–	—2/–	17½F	15F	6 7 3	71/6	55/–	62/6	39/9
1,530,024	1	Ditto A. Ord.	53/6	—3d.	17½F	15F	6 10 9	69/3	53/6	65/6	38/9
1,108,268	5/–	Manganese Bronze & Brass	15/3	+6d.	20⅝	20⅝	6 13 3	18/9	13/4½	19/–	13/6
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	6/6	5/10½	7/9	5/9
21,745,110	Stk. (£1)	Metal Box	84/6	+4/–	12M	13B	2 12 0	84/9	55/9	80/–	44/7½
415,760	Stk. (2/–)	Metal Traders	7/3		50	50	13 15 9	10/4½	7/1½	13/6	8/4½
160,000	1	Mint (The) Birmingham	36/9		10	10	5 8 9	39/–	33/6	35/–	22/–
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	80/–	75/–	80/–	69/–
5,187,938	Stk. (£1)	Morgan Crucible A.	59/–	+6d.	13	12	4 8 3	62/3	47/6	52/6	30/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	16/–		5½	5½	6 17 6	18/6	15/4½	19/3	17/3
3,850,000	Stk. (£1)	Murex	42/6	+1/3	22½J	15	6 5 9	45/–	35/3	76/4½	41/–
585,000	5/–	Ratcliffs (Great Bridge) Ord. ...	16/3	—3d.	10	10R	3 2 0	17/–	14/9		—
195,000	5/–	Ditto 8% Max. Ord.	5/–		8	—	8 0 0	5/3	5/–		—
1,064,280	10/–	Sanderson Kayser	37/–	+9d.	35‡	25	4 14 9	40/3	27/7½	56/–	27/9
2,400,500	Stk. (5/–)	Serck	18/1½	+2/–	12½	17½GD	3 9 0	25/–	15/3	26/–	12/–
7,232,069	Stk. (£1)	Stone-Platt Industries	66/–	+3/9	15	15	4 11 0	66/–	52/3	63/6	42/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/–		5½	5½	7 6 9	18/7½	15/–	18/9	15/10½
33,989,712	Stk. (£1)	Tube Investments Ord.	75/6	+6d.	14	20	3 14 3	95/9	66/3	138/–	71/7½
41,000,000	Stk. (£1)	Vickers	29/9	+1/6	10	10	6 14 6	39/–	27/3	40/6	26/10½
750,000	Stk. (£1)	Ditto Pref 5%	13/–		5	5	7 13 9	17/6	14/–	17/3	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6	+9d.	*5	*5	7 7 6A	24/3	20/–	25/9	20/6
4,594,418	1	Ward (Thos. W.) Ord.	73/9	—1/6	13½	25	3 13 0	86/–	64/–	167/6	83/–
7,109,424	Stk. (£1)	Westinghouse Brake	40/9	+2/3	11	10	5 8 0	59/9	36/6	60/7½	39/–
225,000	2/–	Wolverhampton Die-Casting ...	9/6		35	30	7 7 3	13/10½	8/3	13/1½	8/8½
591,000	5/–	Wolverhampton Metal	27/9	—6d.	32½	27½	5 17 0	39/6	23/9	34/3	21/6
156,930	2/6	Wright, Bindley & Gell	4/3		15	20‡	8 16 6	4/3	2/10½	4/3	2/6
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	15/3	13/3	14/3	12/10½
150,000	1/–	Zinc Alloy Rust Proof	5/–		40	30	8 0 0	5/6	4/–	3/10½	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. ♦The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/– Stock Units. ♦ and 6½% from Capital Profits B and 50% capitalized issue. G and 1½d. special distribution. F and special 5% tax free dividend. H As forecast. ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. N Interim since increased. J and 75%capitalized issue. S and 40% capitalized issue. O calculated at 13⅓%. Interim on smaller capital. P Calculated at 11⅓%. Q also 1/– special tax free dividend and 50% capitalized issue. T Per £1 unit. W Before capital reorganization. Calculated at 15%. Z After capital reorganization

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